A Preliminary Summary of

Progress and Plans

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SUGAR RESEARCH

of the United States Department of Agriculture
and
in cooperation with
State Agricultural Experiment Stations

Prepared for the Department's
SUGAR RESEARCH AND MARKETING ADVISORY COMMITTEE

for its 17th Annual Meeting
Salt Lake City, Utah
November 2-6, 1959

This progress report is primarily a tool for use by advisory committee members in developing recommendations for present and future research programs and by USDA administrators for developing, coordinating, and evaluating research plans. Included in it are summaries of research done during the past year. Some are tentative results that have not been tested sufficiently to justify general release. Such findings, when adequately confirmed, will be released promptly through established channels. Because of this, the report is not intended for publication and should not be referred to in literature citations. Copies are distributed only to advisory committee members, research administrators, and others having special interest in the development of public agricultural research programs.

The report also lists publications of research results issued during the year. Current agricultural research findings are also reported in the monthly USDA publications, "Agricultural Research" and "Agricultural Marketing."

UNITED STATES DEPARTMENT OF AGRICULTURE
Washington, D. C.

FUNCTIONS OF ADVISORY COMMITTEES

The Sugar Committee is one of twenty-five commodity and functional committees of the U. S. Department of Agriculture established pursuant to Title III of the Research and Marketing Act of 1946. Functions of the members of these committees include:

1. Acquainting themselves with the problems of producers, processors, distributors, and consumers, and presenting them for committee consideration.

2. Reviewing the current research and marketing service programs of the Department and recommending adjustments, including terminations, in the current program in order that available funds, personnel and facilities will be used on problems of greatest importance.

3. Recommending new work or expansion of current work and indicating relative priority of such recommendations, when the current program is insufficient to develop solutions for important problems.

4. Developing a better understanding of the nature and value of the agricultural research program, explaining it to interested groups and organizations and encouraging the wider and more rapid application of the findings of research.

The committees perform an important function in advising with respect to the development of the Department's research and marketing service programs. However, committee members recognize that the development of budgets and the implementation and administration of research and marketing programs are responsibilities of the Department.

A progress report similar to this one is prepared for each committee. The areas of the other twenty-four committees are:

Citrus and Subtropical Fruit
Cotton and Cottonseed
Dairy
Deciduous Fruit and Tree Nut
Economics
Farm Equipment and Structures
Feed and Forage
Food and Nutrition
Food Distribution
Forestry
Grain
Home Economics
Livestock
Oilseeds and Peanut
Potato
Poultry
Refrigerated and Frozen Products
Rice
Seed
Sheep and Wool
Soils, Water and Fertilizer
Tobacco
Transportation
Vegetable

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CODES TO DESIGNATE UNITS CONDUCTING RESEARCH

AGRICULTURAL RESEARCH SERVICE (ARS)

Farm Research Divisions

AE----------Agricultural Engineering
ADP----------Animal Disease and Parasite
AH----------Animal Husbandry
CR----------Crops
ENT----------Entomology
FE----------Farm Economics
SWC----------Soil and Water Conservation

Utilization Research and Development Divisions

EU----------Eastern
NU----------Northern
SU----------Southern
WU----------Western

Home Economics Research Divisions

CH----------Clothing and Housing
HHE----------Household Economics
HN----------Human Nutrition

AGRICULTURAL MARKETING SERVICE (AMS)

Marketing Research and Statistics Divisions

AEC ----------Agricultural Economics
AES----------Agricultural Estimates

Marketing Research (MRD) - Branches

BS----------Biological Sciences
MD----------Market Development
OC----------Market Organization and Costs
TF----------Transportation and Facilities

FCS----------FARMER COOPERATIVE SERVICE

FAS----------FOREIGN AGRICULTURAL SERVICE

FOREST SERVICE (FS)

Forest Research Divisions

FDR----------Forest Disease
FER----------Forest Economics
FFR----------Forest Fire
FIR----------Forest Insect
FPR----------Forest Products Utilization
RMR----------Range Management and Wildlife Habitat
WMR----------Watershed Management

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I. FARM RESEARCH

A. Breeding and Genetics

SUGAR BEETS ---------- CR

Problem: Producers need sugar beet varieties that are resistant to diseases and nematodes, improved in yield and quality, and suitable for mechanized production.

Program: This continuing program of applied and basic research involves the application of known principles in genetics and cytology and the development of new breeding techniques for the production of improved inbred lines and varieties. The research is conducted at Beltsville, Maryland, Salt Lake City, Utah, Twin Falls, Idaho, and Salinas, California, and in cooperation with the State Agricultural Experiment Stations of Colorado, Michigan, Minnesota, New Mexico, Idaho, and Utah; and with the beet sugar industry. This research program involves about 12 professional Federal man-years annually.

Progress: Virus Yellows Resistance. The search for sugar beet breeding material carrying a high level of resistance to the yellows virus is being continued through extensive greenhouse and field evaluations. In inoculation experiments involving large quantities of sugar beet breeding material of diverse origin, the various entries have shown reductions, due to virus yellows infection, of 24 to 44 percent in root yield and .35 to .83 percentage points in sucrose percentage. Varieties showing the least damage from virus yellows in field tests tended to perform well the following year, indicating that the present method of appraising disease damage can be used with confidence in the breeding program.

In addition to differences among inbred lines and varieties in the amount of damage resulting from yellows inoculation, marked differences were observed among the sorts in the likelihood of becoming infected under natural spread of the virus by the aphid vector. The incidence of natural infection among a group of varieties ranged from 3 to 35 percent, but susceptibility to natural infection was not directly related to the extent of damage that would be caused by the virus if infection occurred.

Hybridizations between tolerant lines and between tolerant and susceptible lines supplied material for a study of the mode of inheritance of yellows resistance. The results of field tests indicate partial dominance for the resistant character. If this mode of inheritance can be established as a principle for virus yellows of sugar beets, it will be a great aid in the breeding of resistant varieties.

Commercial Monogerm Hybrids. In 1959, for the first time in this country a significant acreage of the sugar beet crop was planted to monogerm hybrid seed, which has greatly facilitated mechanization of thinning. The development of monogerm varieties, which has been brought about by cooperative research, had its beginning with a single monogerm sugar beet found in 1948. Breeding to establish monogerm varieties that are productive and resistant to diseases has shown steady progress. In 1956, monogerm seed was available to

growers for extensive field trials. The monogerm seed production in 1957, which gave seed for grower use in 1958, amounted to 11.4 percent of the seed crop. In 1958, monogerm seed amounted to 28.4 percent of the total production available for grower use in 1959. The monogerm seed production in the 1959 crop, which will supply seed for grower use in 1960, will show a further trend towards monogerm seed in this country.

An essential parental line for the production of monogerm hybrid seed is known as type "O", which carried the genetic factors for pollen sterility but has normal cytoplasm for pollen production. By a series of backcrosses of the type "O" line to a male-sterile sort that carries both genetic and cytoplasmic factors for male sterility, male-sterile equivalents of inbred lines can be produced. Such lines are used as parents in hybrid seed productions. The type "O" plant, which occurs rarely in some breeding stocks, can be identified only through a trial crossing of a pollen-fertile and a pollen-sterile plant. Screening of monogerm breeding material in 1958 gave 12 new type "O" plants that were derived from hybridizations involving US 201, a variety extremely resistant to Cercospora leaf spot. These type "O" lines have great potential value as parental sorts in the production of monogerm hybrids for districts subject to epidemics of leaf spot. Two new type "O" monogerm lines, SL 127 and SL 128, which are resistant to curly top, were produced in 1958. These two lines constitute a definite step forward in the production of curly-top-resistant monogerm hybrids.

Hybrid Varieties for California. US H2 and US H3, two new hybrid varieties that were developed in cooperative breeding research conducted at Salinas, California, have been released for commercial seed production. Both varieties have good curly top resistance and moderately good bolting resistance. These hybrids are adapted for planting in the Imperial Valley, where the sugar beet is grown as a winter crop, as well as in the central valleys of that State. In the production of these hybrids, 3 parents are involved and cytoplasmic male sterility is used as a tool in bringing about hybridizations. First, a pollen-sterile F_1 is produced, which is used as one parent, and then a complementary pollen-fertile line is supplied as the pollen parent, making possible the 3-way commercial hybrid. As an average for 15 tests in California, the root yield of US H2 was 15.6 percent above that of US 75, and the average sucrose percentage of the hybrid was slightly above that of US 75.

The male-sterile F_1's developed at Salinas, in addition to their use in the productions of US H2 and US H3, are being employed extensively in the production of hybrid seed by sugar companies that provide their own pollinators. In fall plantings of 1958, male-sterile sugar beets developed at Salinas were used as the principal seed bearers in an over-wintering crop that is expected to produce more than 1 million pounds of hybrid seed in 1959 for grower use in 1960.

Plans: Breeding for resistance to virus yellows, new strains of the curly top virus, root rotting organisms, and the cyst nematode, has established a firm basis for future progress; but the development of varieties resistant to these hazards is yet to be realized. Desired quality and resistance

to leaf spots and black root will also be given consideration. These promising lines of breeding will be strengthened as part of an over-all program to combine multiple disease resistance and quality in monogerm varieties for the various sugar beet districts.

Publications: Estimation by the Partitioning Method of the Numbers and Proportions of Genetic Deviates in Certain Classes of Frequency Distributions. LeRoy Powers, D. W. Robertson, and A. G. Clark. Jour. Am. Soc. Sugar Beet Tech. IX (8): 677-696. 1958.

Estimation of the Environmental variances and Testing Reliability of Residual Variances for Weight per Root in Sugar Beets. LeRoy Powers, D. W. Robertson, and E. E. Remmenga. Jour. Am. Soc. Sugar Beet Tech. IX(8): 697-708. 1958.

Population Genetic Studies with Sugar Beets (Beta vulgaris L.) at Different Levels of Soil Fertility. LeRoy Powers, D. W. Robertson, Robert S. Whitney, and Willard R. Schmehl. Jour. Am. Soc. Sugar Beet Tech. IX(8): 637-676. 1958.

Genetic Study and Methods of Breeding in Monogerm Beets. V. F. Savitsky. Zeitsch. f. Pflanzenzüchtung 40(pt. 1): 1-36. 1958.

SUGARCANE ---------- CR

Problem: Producers need new varieties of sugarcane having high yielding ability, high quality for processing, and resistance to diseases and to cold damage, that are adapted to mechanical production and harvesting.

Program: The breeding program involves basic research in genetics, cytology, and taxonomy as well as applied research required to develop superior varieties, with crosses being made at Canal Point, Florida, Honolulu, Hawaii, and Rio Piedras, Puerto Rico, and varietal testing being done cooperatively with agricultural experiment stations in Louisiana, Florida, Puerto Rico, Mississippi, and Georgia, and the American Sugar Cane League,the Cairo Cane Growers' League, the Hawaiian Sugar Planters' Association, the Sugar Producers' Association of Puerto Rico, and the Land Authority of Puerto Rico, involving about 7 professional Federal man-years annually.

Progress: Varieties. Three new varieties, C.P. 53-1, C.P. 53-15, and C. P. 53-18, developed in the breeding and testing program, produced higher yields of cane and sugar per acre on heavy soils in Louisiana than the principal commercial variety, C.P. 44-101. Though these varieties are potential condidates for release to growers, further information is needed about their stubbling qualities. In preliminary tests, C.P. 53-18 produced approximately the same amount of sugar per ton of cane in late September and throughout most of the harvesting season as C.P. 48-103; the latter is the best early-maturing variety available to sugarcane farmers in Louisiana.

In Florida, C.P. 52-107 produced higher yields of sugar per acre than the principal variety, Cl. 41-223, in first-year stubble tests in the Okeelanta area; it is being increased to provide potential material for release to farmers. Results from plant cane and stubble experiments show that C.P. 52-48 is the most promising variety for sirup production in south Georgia; further tests are needed to confirm these results. P.R. 980 produced the highest yields of sugar per acre in ratoon crops in Puerto Rico under most conditions. P.R. 1013, P.R. 1016, and P.R. 1048 gave high yields under some conditions in Puerto Rico.

Crosses and Seedlings. During the 1958-59 breeding season, the use of improved techniques inside a new, plastic-covered crossing house constructed during 1958, resulted in an unparalleled success in the production of sugarcane seed at Canal Point, Florida. A total of approximately 1,900,000 viable seed were produced from superior parental combinations of high sucrose parents and from promising crosses not successfully made in the past; this production was an increase of more than 300 percent as compared with the most successful breeding season prior to this time. A total of 928 crosses were made at Canal Point, Florida, and at Rio Piedras, Puerto Rico, in the 1958-59 breeding season. From these crosses, a total of 639,000 seedlings were planted in Puerto Rico, Florida, Louisiana, Mississippi, and Georgia. The polycross method of breeding, initiated in Puerto Rico during 1957, furnished seed for 19,000 seedlings used in the Mainland varietal improvement program.

World Collection. One hundred and ten varieties of sugarcane from the best breeding programs of the world were imported from 11 countries during the year. These varieties were selected for importation because of their high sugar content, lodging and disease resistance, yielding ability, cold resistance adaptability to adverse conditions, and other desirable characteristics; they will be screened for possible use in the breeding program and for commercial culture. Four hundred and sixteen varieties were requested by and shipped to 27 countries.

Cytological Studies. Cytological studies at Beltsville, Maryland, during 1958 indicate that wild species of sugarcane in the 57 N.G. collection (now in quarantine) contain a wide range of new,promising genetic material. This detailed information will be valuable in utilizing the new varieties in the sugarcane breeding programs at Canal Point, Florida, at Rio Piedras, Puerto Rico, in Hawaii, and in other countries.

Botanical Studies. Intergeneric crosses between Saccharum and four genera, Sorghum, Erianthus, Miscanthus, and Sclerostachya, were accomplished at Canal Point during 1958. Screening, testing, and backcrossing this material will be done as rapidly as possible to provide valuable material for the sugarcane breeding program. Such important characters as early maturity, disease and cold resistance, and lodging resistance may be obtained from this intergeneric material.

Plans: The breeding program will be strengthened by increasing the number of seedlings tested annually and by the use of additional trained professional personnel in the extensive selection and testing work. Studies on

selection criteria and techniques for handling the seedlings will be expanded to develop improved methods and increase the efficiency of these operations. Crossing, testing, and other phases of the breeding work will be continued on about the same level.

Publications: Transition: Effectiveness and Implications of Breeding Sugarcane in an Indoor Environment at Canal Point. P. H. Dunckelman. Sugar Bul. 37(19): 229-252. 1959.

Notes from Canal Point, Florida, 1957 Breeding Season. P. H. Dunckelman. Internat. Soc. Sug. Cane Tech. Newsletter 4. 1958.

USDA Sugarcane-Sorghum Hybridization. C. O. Grassl. Sorghum Newsletter 2. 1959.

The 1957 Sugarcane Expedition to Melanesia. J. N. Warner and C. O. Grassl. Hawaiian Planters' Record LV. 1958, No. 3.

The Louisiana Sugarcane Variety Census for 1959. L. P. Hebert. Sugar Bul. 37(16): 191-194. 1959.

Breeding Behavior of Certain Agronomic Characters in Progenies of Sugarcane Crosses. L. P. Hebert and M. T. Henderson. USDA Tech. Bul. 1194, 54 pp. 1959.

Critique on Apomixis in Sugarcane. Sam Price. Economic Botany 13(1): 67-74. 1959.

Reply to Skinner's Rebuttal. Sam Price. Internat. Soc. Sug. Cane Tech. Newsletter 6. 1959.

SWEET SORGHUM ---------- CR

Problem: New and improved varieties of sweet sorghum that have high yielding ability and high sugar content, resistance to diseases and lodging, and that are adapted for sirup and sugar production are needed for a wide range of environmental conditions in the United States.

Program: A continuing, long-time program involving basic breeding and genetic studies as well as the application of known principles of plant breeding in development of new varieties is carried out at Beltsville, Maryland; Meridian, Mississippi; Cairo, Georgia; and Brawley, California. Testing of new selections is in cooperation with State Agricultural Experiment Stations in Louisiana, Mississippi, Alabama, Georgia, South Carolina, Tennessee, Kentucky, and California; and in cooperation with the Cairo Cane Growers' League, involving about 2 professional Federal man-years annually.

Progress: Varieties. New, promising disease-resistant varieties of sweet sorghum are being tested in the Southeastern States and in California, that appear to have superior agronomic and milling qualities for sirup and

sugar production. One of these varieties, Mer. 55-10, matures in about 80 days; it is disease-resistant and it produces a good quality of sirup throughout the South. Head-to-row tests are being conducted to increase the uniformity of this variety. Another variety, Mer. 55-1, is promising for sugar production in the Southern States; it is resistant to rust, Zonate leaf spot, and red rot and it produces a high sucrose under normal conditions. Tests are being conducted to determine its adaptability to sugarcane-producing areas in Louisiana. Brawley is an outstanding variety for the Imperial Valley of California. Wiley continues to be the leading variety for sirup production in the Southeastern States.

Hybrid Varieties. Further tests confirm previous data that Kansas sorgo hybrids between male-sterile Combine 60 and sweet sorghum varieties have a lower yield and quality for sirup and sugar production than the sweet sorghum parents and the present commercial varieties, under conditions in the Southeastern States. Extensive tests are in progress to transfer the male-sterile character from grain sorghum to sweet sorghum varieties. Tests are also in progress to evaluate the potential of hybrid vigor for increasing yields of stalks and sugar under conditions in the Southeastern States and in California.

Inheritance Studies. Population studies in F_1 and F_3 generations and crosses between susceptible and resistant varieties in Mississippi and Louisiana indicate that resistance to Zonate leaf spot, Gloeocercospora sorghi, is controlled by one genetic factor pair, with resistance dominant. The designation Glgl is suggested for this allemorphic pair in sorghum.

World Reference Collection. Three hundred and fifty-nine varieties of sweet sorghum were received from 38 countries. Most of these varieties possess high yielding ability, disease resistance, and high sugar content; some of them have been imported for basic genetic studies. Two hundred and ninety-eight varieties were requested by and sent to 14 countries during 1958.

Plans: The breeding, genetic, and testing work will be continued on about the same level. Special consideration will be given to exploring the possibility of developing hybrid varieties having high yielding ability, disease resistance, lodging resistance, and superior qualities for sirup and sugar production.

Publications: The Inheritance of Zonate Leaf Spot in Sorghum. O. H. Coleman. Proc. Assoc. Southern Agri. Workers. 1959.

Cooperative Sorgo Variety Tests in Southeastern United States in 1957. O. H. Coleman, D. M. Broadhead, and K. C. Freeman. Mimeo. progress report for extensive distribution to interested agencies. 13 pp.

A Device for greenhouse and field Emasculation of Sweet Sorghum Flowers. Charles Price. Agron. Jour. 50(12): 263. 1958.

B. Physiology and Nutrition

SUGAR BEETS ---------- CR

Problem: Improvement of quality and yield and the reduction of spoilage through the development of production procedures that are better adjusted to environmental factors and to nutritional requirements.

Program: A continuing program of basic and applied research concerning environmental factors, nutrition, and chemical treatments affecting growth, keeping quality, composition, and predisposition to disease. The work is carried on at Beltsville, Maryland; at the Federal stations at Salt Lake City, Utah, and Salinas, California; in cooperation with the State Agricultural Experiment Stations of California, Colorado, Michigan, and Utah; and with the beet sugar industry. This research involves about 3 professional Federal man-years annually.

Progress: Chemical Treatment for Pollen Suppression. There has been need for the control of pollen production in sugar beets as a means of bring about hybrid seed production. In some lines, the production of pollen is under the control of genetic and cytoplasmic factors, but in other lines, it would be desirable if restriction in pollen production could be obtained through other means. Experiments have been conducted with sodium 2,3-dichloroisobutyrate (FW-450) as a selective gametocide on sugar beets. Greenhouse experiments in which 0.5 percent of this growth-regulating substance was applied as a spray to seed plants resulted in an increase in hybrids from 3.5 percent in the untreated to 40.3 percent in treated plants. Of significance in these experiments was a differential response among inbred lines as to the effect of the gametocide on seed yield and on germination percentage. Studies are being continued to determine the potential of the chemical as a selective gametocide in the sugar beet and to explore its use as an aid in hybrid seed production. Application has been made for a public service patent on the use of the chemical on sugar beets.

Nutrition Levels and Selection for Quality Improvement. It has been demonstrated that fertility levels and nutrition balance have a marked influence on the quality of the sugar beet. Using the percentage of nitrogen, sodium, and potassium as indicators of quality, in addition to sucrose percentage, the principles of population genetics have been applied to studies of quality of roots when produced under different levels of fertility. Analyses of frequency distributions of plants from 2 levels of fertility reveal that it should be possible to select individuals in which the sodium concentration is genetically conditioned. The studies further reveal that selection for low sodium could be more readily accomplished on non-fertilized plots, while effective selections for high or for low patassium were not significantly influenced by fertility level.

Nearly complete dominance of smaller amounts of total nitrogen was found for those replicated groups in which the total nitrogen averaged above a base value, whereas heterosis for smaller amounts of nitrogen was found for those replicated groups in which the total nitrogen averaged less than the base value. The findings in the relation of fertilizer to plant population

responses lend considerable encouragement to the plant breeder, since they provide evidence that sugar beets can be bred for either high or low nitrogen content. The accomplishments are expected to be more marked at the higher fertility level, for which improved varieties are most needed.

Plans: The work will be continued with emphasis on the improvement of quality in relation to nutritional levels and the reduction of losses in harvested root as well as on the application of chemicals and the influence of environment on the growth and development of the sugar beet.

Publications: Effect of High Energy Electron Irradiation On Respiration of Whole Sugar Beet Roots. F. W. Snyder and D. E. Winant. Jour. Am. Soc. Sugar Beet Tech. X(4), 3 pp. 1959.

Effects of Climate on Sugar Beets Grown Under Standardized Conditions. Albert Ulrich, et al. Jour. Am. Soc. Sugar Beet Tech. X(1): 1-23. 1958.

Some Effects of Gibberellic Acid on the Physiology of Sugar Beets. Myron Stout Jour. Am. Soc. Sugar Beet Tech. X(4), 6 pp. 1959.

Effect of Gibberellic Acid on Rate of Bolting of Annual Beets. Myron Stout and F. V. Owen. Jour. Am. Soc. Sugar Beet Tech. X(4), 3 pp. 1959.

SUGARCANE ---------- CR

Problem: Evaluate physiological factors that influence flowering of sugarcane and the deterioration of standing and harvested cane, and methods of their control. Develop improved methods for furnishing high quality cane to the factory, and fertilizer practices required to obtain maximum production of current commercial and new varieties of sugarcane.

Program: A continuing, long-term program of basic studies of physiological factors and nutritional practices, and applied research required to develop useful commercial practices is carried on in Louisiana, Mississippi, Alabama, and Georgia, in cooperation with State Agricultural Experiment Stations, the American Sugar Cane League, the Cairo Cane Growers' League, and the Hawaiian Sugar Planters' Association, involving about 3 professional Federal man-years annually.

Progress: Physiological Studies. Low germination of seedcane under field conditions in Louisiana is associated with length of the seed piece. Seed pieces having more than five or six buds gave low germination under field conditions. In Georgia, seed pieces about 20 inches long produced higher yields of sirup per acre than whole, uncut stalks.

Chemical treatment of sugarcane in Louisiana with a desiccant, FB-2 (1:1 ethylene-2:2 dithyridylium dibromide), caused green leaves of sugarcane to become dry enough for effective burning within two days after application, under favorable conditions. Sucrose development remained unchanged for approximately 28 days after application of the desiccant.

Cold tolerance tests of sugarcane in Louisiana, by a recently developed "freeze-dip" method show that N. Co. 310 and five unreleased C.P. selections are superior in this characteristic to current commercial varieties; they are classified as "tolerant" to cold damage. Inversion of sucrose in short pieces of stalks collected from cane harvested by mechanical equipment was greater than in entire stalks under Louisiana conditions. Foliar applications of gibberellic acid seven to fourteen days before harvest did not increase or decrease the sucrose content of sugarcane in Louisiana.

Comparisons show that milling wet trashy cane as compared to dry, clean cane results in a loss of one dollar or more per ton of cane in Louisiana. Topping millable cane 6 to 9 inches lower than normal reduced the total amount of green trash sent to the mill by 14 percent; this practice may improve sugar recovery and be economically valuable under some conditions.

Yields of cane per acre with four leading varieties were increased under Louisiana conditions by the applications of the herbicide, Dalapon; applications of two or four pounds per acre in April or June were adequate.

Physiological studies in Hawaii show that artificial induction of tasseling in sugarcane can be obtained with a constant photoperiod of 12.5 hours, following suitable pre-induction treatments; highly desirable intergeneric crosses were made by this method.

Studies in Louisiana show no significant variety nitrogen interactions under normal conditions. Significant increases in yield were obtained from high applications of nitrogen, 120 pounds per acre as compared to 40 pounds. The difference between yields from 80 and 120 pounds of nitrogen per acre was usually not significant.

Plans: Physiological studies will be continued on about the same level, including the testing of new chemicals as desiccants and new, promising selections for cold resistance. Nutrition studies will be revised and expanded to include limited basic studies on nitrogen utilization by the sugarcane plants.

Publications: Factors Affecting the Flowering of Sugarcane. R. E. Coleman. Proc. Amer. Soc. Plant Phys. and the Phys. Sec., Bot. Soc. of America Meetings. Page XXVI.

Quality of Harvested Cane Affected by Trash and Topping. R. E. Coleman. Sugar Jour. 22(12):9-11. 1959.

Fertilizer Investigations on Sugarcane at the Houma Station in 1957. L. G. Davidson. Sug. Bul. 37(7):86-94. Jan. 1, 1959.

Recovery of yields of Sugarcane From Adequate Fertilization of Low-Fertility Land. E. S. Lyons. Agron. Jour. 50(12): 762. 1958.

SWEET SORGHUM ---------- CR

Problem: Evaluate physiological factors that influence the quality of sirup and the deterioration of juice quality between harvesting and milling, and develop improved fertility and handling practices required for optimum production of and maximum return from current commercial and new varieties of sweet sorghum.

Program: A continuing, long-term program of basic physiological and nutritional studies, including sirup quality factors associated with fertility practices, and applied research required to develop useful commercial practices is carried on in Mississippi and Georgia, and at Beltsville, Maryland, in cooperation with State Experiment Stations and the Cairo Cane Growers' League, involving less than 1 professional Federal man-year annually.

Progress: Physiological Studies. Comparative tests in Mississippi confirm previous indications that storage of sweet sorghum for 6 days after harvest improves clarification and quality of the sirup, when harvested in the optimum and other stages of maturity. The quality of sirup was also improved by removing the leaves from the stalks prior to milling.

Maleic Hydrazide. Yields of sweet sorghum stalks were lower when the young plants were sprayed with a 1.6 percent solution of maleic hydrazide; lower concentrations did not influence the yield. The sugar content was increased when maleic hydrazide was applied at the floral initiation and flag stages of maturity. Maleic hydrazide had no effect on the rate of inversion of sucrose in the stalks during storage for 7 days prior to milling.

Fertility Studies. Nitrogen is the most important fertilizer element needed for sweet sorghum under most conditions. There was no improvement of yield from 80 pounds of nitrogen per acre as compared to 40 pounds under Mississippi conditions. Phosphorous and potash had no significant influence on the yield of sweet sorghum under most soil conditions.

Plans: Physiological and nutritional studies will be continued on about the same level with emphasis on quality factors that influence clarification, yield, and quality of sirup and exploratory tests to determine the potential for high fertilization of sweet sorghum in the Southeast.

Publication: Some Effects of Maleic Hydrazide on Sart Sorgo. Jack L. Dean and O. H. Coleman. Proc., Assoc. of Southern Agri. Workers. February , 1959.

C. Cultural Practices

SUGAR BEETS ---------- CR

Problem: More information is needed by producers with respect to fertilization, irrigation, spacing, and the sequence of sugar beets in the cropping system in order to improve yield, quality, stand establishment, and disease control.

Program: A long-term program of applied agronomic research conducted at Federal field stations at Salinas, California, and Salt Lake City, Utah; in cooperation with the State Agricultural Experiment Stations of California, Colorado, Michigan, Minnesota, New Mexico, Idaho, and Utah; and cooperatively with the beet sugar industry. The work involves about 2 professional Federal man-years annually.

Progress: Cooperative investigations have shown that spacing of sugar beets significantly influences sucrose percentage. Spacing of plants along the row was more of a factor influencing quality than row widths ranging from 28 to 40 inches. Varieties differ in their ability to utilize space; therefore, if yields are to be maintained with certain varieties, it will be necessary to adjust spacing to varietal requirements.

Plans: Work on the long-term program of research will continue at about the same level of activity, with more emphasis on the introduction of regionally adapted monogerm varieties that will facilitate mechanized production. Studies will be continued on agronomic practices of nutrition, soil amendment, spacing, and crop sequence as they affect stand establishment, disease incidence, yield, and quality.

SUGARCANE ---------- CR

Problem: Develop improved and more economical cultural practices to obtain optimum production of commercial and new varieties of sugarcane.

Program: A continuing program of basic and applied research on cultural practices is carried on in Louisiana, Mississippi, Alabama, and Georgia in cooperation with State Agricultural Experiment Stations, the American Sugar Cane League, and the Cairo Cane Growers' League, involving about 1 professional Federal man-year annually.

Progress: Time of Planting. Summer planting of sugarcane was superior to fall planting in the western area of the Louisiana "Sugar Belt" during 1958.

Fertility Studies. The highest yields of sugar per acre were obtained in Louisiana when sugarcane trash was buried and the soybean crop (green manure) was turned under.

Tillage Studies. Deep tillage does not improve water permeability, bulk density of the soil, or the percent of large pore space under Louisiana conditions; also, it did not significantly influence the yield of cane or sugar per acre.

Depth of Planting. There was no difference in the yield of sirup per acre when seedcane was planted at depths of 1-1/2, 3 and 4-1/2 inches in Mississippi, Alabama, and Georgia.

Width of Row Studies. Yields of sirup per acre were higher when sugarcane was planted in 3- or 3-1/2-foot rows than when planted in 5- or 6-foot rows in Mississippi and Georgia.

Time of Harvesting. Early harvesting of sugarcane in October produced yields of sirup per acre and poor stands in the succeeding stubble crop, as compared to harvesting in mid-November under Georgia conditions.

Herbicides. Yields of sugarcane were improved by applications of Dalapon for the control of weeds under Louisiana conditions. This important improvement in yield was observed in summer- and fall-planted sugarcane.

Plans: Cultural studies will continue on about the same level. Since factors that influence results of these studies vary greatly from year to year in accordance with seasonal conditions and with the type of varieties, and since cumulative effects are important, basic research will be expanded and continued over a period of several years.

Publication: Effect of Depth of Placement of Seed Piece and Date of Planting on Yields of Cane and Sugar from C.P. 36-105 and C.P. 44-101 at Houma, Louisiana. L. P. Hebert and R. J. Matherne. Sugar Bul. 37(20): 260-266. 1957.

SWEET SORGHUM ---------- CR

Problem: Develop improved and more economical cultural practices required for optimum production of current commercial and new varieties of sweet sorghum.

Program: A continuing, long-term program of basic studies of cultural practices to obtain essential information for use in applied research required to develop more useful commercial practices is carried on in Mississippi and Georgia, at Brawley, California, and at Beltsville, Maryland; in cooperation with State Agricultural Experiment Stations, and with the Cairo Cane Growers' League, involving less than 1 professional Federal man-year annually.

Progress: Plant Arrangement Studies. Sweet sorghum plants spaced 1 and 3 inches apart in drills gave lower extractions and more lodging than comparable plants spaced 9 and 12 inches in drills or plants spaced in hills 24 inches apart (3 plants in each hill)in Mississippi. In California, plants spaced 4 inches apart in drills lodged twice as much as the same number of plants per acre arranged in hills 24 inches apart.

Sirup Quality. Comparative tests in Mississippi show that a good quality of sirup can be produced when the plants are in the flowering stage of maturity; however, the yield is lower than when harvested at the optimum time in the dough stage. Stalks that were stripped and topped made a better quality of sirup than when the entire plant was milled. In general, plants that were stripped but left standing in the field did not produce a good quality of sirup.

Plans: Cultural studies will be continued on about the same level, with emphasis on time of planting, time and method of harvesting, and on the arrangement of plants in the row.

Publication: Sorgo Spacing Studies in Mississippi. D. M. Broadhead. Proc. Assoc. Southern Agri. Workers. 1959.

SOIL AND WATER MANAGEMENT AND CONSERVATION ---------- SWC

Problem: Determine the most profitable rotations and develop more efficient soil and water management practices for sugar beets and sugarcane.

Program: This long-term continuing program involves rotation studies, fertilizer needs, moisture conservation, and consumptive use of water to evaluate the proper sugar beet and sugar cane plant-soil-water relationship. The work is in cooperation with 8 state experiment stations and involves about 2 professional Federal man-years annually.

Progress: Tillage and Soil Management Practices. Soil physical characteristics of each horizon in the soil profile have a controlling influence on the soil and water management requirements of that soil for crop production. During 1958, such characterizations were completed for 97 selected soil types in the Eastern half of the country. This included 15 profiles in Louisiana where sugarcane is grown. These data have already been used to modify irrigation guides and should have considerable influence on drainage system design also. Several tillage methods have been successfully used to reduce the detrimental effects of hardpans on compacted layers that limited subsoil moisture recharge and limited rooting depth. Land forming procedures have been refined in Louisiana to provide better surface drainage for sugarcane. These procedures have resulted in marked increases in crop yield and in machine efficiency in production and harvesting operations.

An intensive study of row grades and row lengths on efficiency of removal of excess surface water without undue erosion of soil is being initiated in Louisiana. Detailed soil physical measurements have been completed at the 3-6 inch, 9-12 inch, and 12-15 inch depths at 132 locations within the 90 acre block of soil to be devoted to these studies. Similar measurements will be made after the necessary land forming operations are completed in order to evaluate the effects of land forming on soil physical properties. One replicate is complete. The other three replicates of the experiment will be finished over a two-year period. Row lengths will be 500, 700, 900, and 1100 feet long with row grades of .10, .15, .20, or .25 percent. Provisions for measuring runoff and erosion losses are being installed.

There were no differences in soil moisture contents or sugar beet yields where row grades, as a result of land forming, were 0.2 percent or 0.5 percent, or where row lengths were 320 or 640 feet in length. The removal of topsoil during land forming operations resulted in yield reduction during the first year after forming. This may be attributed to the lower fertility status

of the exposed subsoil or to inadequate outlets at the lower end of the formed plots. Costs of land forming increased rapidly whenever degree or length of slope were increased on nearly level land.

Rotations: Sugar beet, bean and alfalfa yields were approximately equal on the "best judgment" and "maximum yield" rotations but sugar production on the "best judgment" rotation was superior due to a 1.8 percent higher sugar content. In similar studies comparing continuous cropping of various crops with cropping in a rotation system including alfalfa at Prosser, Washington, alfalfa and potato yields were higher on continuous cropping and sugar beet, field bean, corn and wheat yields were higher on the rotation plots. Grassy weeds were a major problem in both rotation and continuous cropped plots of sugar beets, field beans and wheat.

Plans: Since nutrient uptake has been shown to be associated with moisture uptake, it is planned to investigate methods of controlling nitrogen and water and their interactions in order to enhance sucrose production and plant quality. Rotation studies will continue at about the same level.

D. Weed Control

SUGAR BEETS ---------- CR

Problem: Develop new and improved chemical, biological, cultural, and mechanical methods for controlling weeds in sugar beets.

Program: This is a long-term continuing research program on the improvement of weed control methods for sugar beets, including studies on the physiological responses of the crop to these methods as reflected in yield and quality. These studies are conducted in cooperation with the State Experiment Stations in Arizona, Montana, Michigan, and Minnesota and involve approximately 2 professional Federal man-years annually.

Progress: Pre-emergence applications of CDEC at 5 lb/A effectively controlled purslane and pigweed in sugar beets grown for seed in Arizona. Pre-planting soil-incorporated applications of Endothal also appeared promising.

Effective control of annual grasses and certain broadleaved weeds was obtained in Michigan with pre-emergence applications of TCA, Dalapon, Endothal, CDEC, and EPTC; while in Minnesota, post-emergence applications of Endothal at 2 lb/A effectively controlled ladysthumb (Polygonum persicaria) and wild buckwheat (Polygonum convolvulus). Soil-incorporation of EPTC and Endothal increased their effectiveness for weed control in sugar beets; however, yields were significantly reduced by these treatments in Montana.

Plans: Investigations will be continued to evaluate promising new herbicides for the selective control of weeds in sugar beets under irrigated and non-irrigated conditions. Basic studies will be continued to determine the physiological responses of sugar beets and important weeds to promising herbicides under various soil and environmental conditions.

Publications: Weed Control in Sugar Beets. Robert N. Andersen. Prox.NCWCC.1958.

Pre-emergence Herbicide Evaluation Trials in Sugar Beets. (Abstract). Robert N. Andersen. NCWCC Res. Prog. Rept. 1958.

An Evaluation of Pre-planting Soil Incorporation Treatments for Weed Control in Sugar Beets. (Abstract). Robert N. Andersen, NCWCC Res. Prog. Rept. 1958.

Control of Wild Oats by Prevention of Normal Seed Development with Sodium 2,2-dichloropropionate. Robert N. Andersen and E. A. Helgeson. Weeds 6(3): 263-270. 1958.

An Evaluation of Several Chemicals for Their Herbicidal Properties - 1958 Field Results. W. A. Gentner and W. C. Shaw. CR-6-59 ARS, USDA.

Sugar Beet Weed Control with Pre-Planting and Pre-Emergence Herbicide Treatments. (Abstract). Jesse M. Hodgson. WWCC Res. Prog. Rept. pp. 49-50. 1959.

SUGARCANE ---------- CR

Problem: Annual and perennial weeds present serious problems in the production of sugarcane, and more efficient chemical, cultural, biological, and mechanical methods are needed to control these weeds. Of particular importance is the threat posed by the possible spread of witchweed to the major sugarcane producing areas.

Program: Cooperative studies are under way to evaluate the resistance of sugarcane varieties to witchweed and to develop chemical, cultural, biological, and mechanical methods for the control and progressive eradication of witchweed in the only known infestations in North and South Carolina. Less than 1 professional Federal man-year is devoted to the work on sugarcane.

Progress: Forty varieties of sugarcane were evaluated for their tolerance to witchweed infestations. Several varieties showed considerable tolerance to witchweed.

Plans: The cooperative work on the evaluation of genetic resistance of sugarcane varieties and breeding lines to witchweed will be continued. Increased work is planned in the development of more efficient control measures for the progressive eradication of witchweed to prevent spread to the sugarcane growing areas of the United States.

Publication: Progress Report on Witchweed Research. E. L. Robinson. What's New in Crops and Soils. 1958.

SWEET SORGHUM ---------- CR

Problem: Annual and perennial weeds present serious problems in the production of sweet sorghum, and more efficient chemical, cultural, biological, and mechanical methods are needed to control these weeds. Of particular importance is the threat posed by the possible spread of witchweed to the major sweet sorghum producing areas.

Program: Cooperative studies are under way to evaluate the resistance of sweet sorghum varieties to witchweed and to develop chemical, cultural, biological, and mechanical methods for the control and progressive eradication of witchweed in the only known infestations in North and South Carolina. Less than 1 professional Federal man-year is devoted to the work on sweet sorghum.

Progress: One hundred and seventy-one varieties of sweet sorghum were evaluated for their tolerance to witchweed infestations. Sorghums in general were less tolerant than sugarcane, but several varieties of both sweet and grain sorghums showed some tolerance to light infestations of witchweed.

Plans: The cooperative work on the evaluation of genetic resistance of sweet sorghum varieties and breeding lines to witchweed will be continued. Increased work is planned in the development of more efficient control measures for the progressive eradication of witchweed to prevent spread to the sweet sorghum growing areas of the United States.

E. Disease and Nematode Control

SUGAR BEETS ---------- CR

Problem: Sugar Beet diseases and nematodes continue to cause heavy losses to growers, and more information is required concerning the causal agents and transmission of various diseases and means of control of diseases and nematodes.

Program: A long-term program of basic and applied research concerning sugar beet diseases, including appraisal of damage, determination of strains of the causal agents, host range of the pathogens and their transmission, and environmental factors and field practices influencing epidemiology, are essential information for the development of control through the application of direct measures and through the development of resistant varieties. Various crop plants and weeds have been evaluated for trap crop characteristics at Salinas, California. The work on these projects involves about 7 professional Federal man-years annually.

Progress: Virus Yellows Damage. Root yields and sucrose content of sugar beets in the San Joaquin Valley of California were very low in 1958 and slightly lower than in 1957 when the loss was estimated at 1 million dollars. Much of this damage is caused by virus yellows, although other factors are involved, such as improper application of fertilizers and other field practices. In 1958, virus yellows occurred in other sections of California and in the Pacific Northwest, with about the same distribution and intensity as in 1957. The attempt to reduce damage from virus yellows in the San Joaquin Valley through establishment of a period extending through the month of December 1957 that was free of sugar beets did not show a reduction in the occurrence of the disease in 1958. The failure of this effort to reduce the primary sources of inoculum is thought to be due to a prolonged period of rainy weather which favored abundant growth of vegetation

in the region, thereby giving rise to an unusually high population of aphids. The rainy season also favored the survival of sugar beets left in the harvested field, which supplied the primary inoculum carried by the apid vectors. There is evidence indicating that the presence of the yellows virus disease in the plant makes it more susceptible to other diseases, thus increasing losses.

The widespread occurrence of virus yellows in the beet-seed-producing areas of the Salt River Valley of Arizona and in the Williamette Valley of Oregon, as well as in the seed-producing areas of California, may cause substantial losses in the production of commercial seed in these areas. The estimated loss of 30 percent in the seed yields in certain fields in the Salt River Valley, due to virus yellows, is in line with results of damage appraisal tests conducted at Salinas, California. Infections in May, when the seedstalks were already elongated, brought about a reduction of 18 to 22 percent in seed yields, while infection at an earlier stage in the development of the seed plants resulted in yield reductions as great as 70 percent.

Rhizoctonia Rot and Other Root Diseases. Rhizoctonia root rot continues to spread and is causing serious damage in several sugar beet growing districts. Cooperative investigations have established the existence of striking differences in pathogenicity of various isolates of the fungus on the sugar beet. These investigations have demonstrated that losses from this soil-borne organism can be reduced through soil treatments with certain fungicides.

Although differences in virulence among isolates of the black root pathogen, Aphanomyces cochlioides, have been found, the isolates have not displayed differential ability to cause damage on a large collection of sugar beet strains and on certain weed hosts.

Curly Top and Other Virus Diseases. The occurrence of new pathogenic strains of the causal agents of plant diseases is frequently a threat to disease control through the use of resistant varieties. The occurrence and potential importance of Strain 11 of the curly top virus in the Intermountain region was mentioned in the report of 1957. In 1958, a new strain of the curly top virus was found in sugar beet seed fields of the Salt River Valley of Arizona. The spread of these new strains of the curly top virus is being followed with much concern. A new strain of the yellows virus was found on radish in the Salinas Valley of California.

The occurrence in 1958 of sugar beet plants infected with curly top in experimental fields of the Plant Industry Station, Beltsville, Md., is worthy of record.

Nematodes. Of the trap crops so far studied, navy beans and celery were found to produce significant amounts of the hatching factor, while lettuce did not. Trap crops are plants which produce a "hatching factor" to cause emergence of the larvae from the cysts, and the roots are attractive to the larvae so that they are entered freely, but there is no reproduction. Both bean and celery roots were entered freely by the sugar beet nematode larvae and there was no reproduction in either.

Apparently beans and celery would have some value as trap crops for the sugar beet nematode, but lettuce would not. Mother-of-the-Evening or Dame's violet (Hesperis matronalis) also produces the hatching factor and the roots are entered freely by the nematodes without reproduction. However, it has no econcmic value.

Breeding for nematode resistance at Salinas, California, is showing promising progress but continued work is necessary to obtain a sufficiently high level of resistance to be of practical value.

Plans: Some shifts have been made in the research on sugar beet diseases to give more emphasis to nematodes and virus yellows. However, a final solution to these serious problems will be a long-term program at the present level of activity. The importance of strains of viruses causing disease in sugar beets will continue to receive attention in relation to the involvement of strains in breeding for disease resistance. Breeding for resistance to nematodes will continue as well as research on other methods of control. A program of study on Rhizoctonia rot and other pathogens causing root spoilage before and after harvest and on soil organisms involved in seedling emergence and stand establishment will be continued on present levels of activity.

Publications: Some Aspects of the Virus Yellows Problem on Sugar Beet in California. C. W. Bennet. California Sugar Beet, pp. 36, 37, 50. 1958.

Curly Top Disease in Turkey and Its Relationship to Curly Top in North America. C. W. Bennett and Aziz Tanrisever. Jour. Am. Soc. Sugar Beet Tech. X (3): 189-211. 1958.

Cucumber Mosaic in Seed Fields of Sugar Beet in the Salt River Valley of Arizona. C. W. Bennett, Harold K. Jewell, and Orin A. Hills. Jour. Am. Soc. Sugar Beet Tech. X(3): 220-231. 1958.

A Latent Virus of California Artichokes. A. S. Costa, J. E. Duffus, D. Morton, C. E.Yarwood, and Roy Bardin. Phytopathology 49(1):49-53. 1959.

The Stability of Sugar Beet Curly-Top Virus Strains. N. J. Giddings. Jour. Am. Soc. Sugar Beet Tech. X(4), 5 pp. 1959.

Varietal Reaction of Sugar Beets to Curly Top Virus Strain 11 under Field Conditions. A. M. Murphy, C. W. Bennett, and F. V. Owen. Jour. Am. Soc. Sugar Beet Tech. X(4), 2 pp. 1959.

Further Studies on the Host Range of Aphanomyces Cochlioides. C. L. Schneider, Phytopathology 48 (8): 463-464. 1958.

Interrelationships of Certain Beta species and Heterodera schachtii, the sugar beet nematode. A. M. Golden, U. S. Department of Agriculture Plant Disease Reporter. Vol. 42(10):1157-1162. October, 1958.

Unusual Response of Hesperis matronalis L. to root-knot Nematodes (Meloidogyn spp.) A. M. Golden and Thelma Shafer, U. S. Dept. Ag. Plant Disease Reporter 42(10):1163-1166. Oct. 1958.

SUGARCANE ---------- CR

Problem: Determine the distribution, prevalence, means of transmission, and methods for controlling sugarcane diseases and nematodes.

Program: A long-term program of basic research on causitive agents, disease characteristics, and host reactions, and applied research on methods of controlling diseases are conducted in Louisiana, Florida, Puerto Rico, Mississippi, Alabama, and Georgia in cooperation with State Agricultural Experiment Stations, the American Sugar Cane League, the Cairo Cane Growers' League, the Sugar Producers' Association of Puerto Rico and the Land Authority of Puerto Rico. Cooperative studies were conducted with the Hawaiian Sugar Planters' Association on Nematodes as a factor in yield decline in sugarcane varieties. This work involves between 2 - 3 professional Federal man-years annually.

Progress: Mosaic. Disease surveys show an important increase in mosaic caused by a new strain of the virus in eastern areas of the sugarcane district in Louisiana. All commercial varieties are susceptible to the disease; however, the greatest damage observed has been in N. Co. 310, C.P. 52-68, and C. P. 44-101. Results from controlled experiments show that in yields of cane, losses range from 14 to 33 percent. Control of the disease by roguing is impractical under some conditions of high infection.

Artificial inoculation of sugarcane seedlings with mosaic-infected juice gave higher infection than insect transmission of the virus under natural conditions in Mississippi. All plants susceptible to the disease under field conditions were infected when inoculated artifically.

Ratoon Stunting Disease. Infection of healthy sugarcane with the ratoon stunting disease is influenced by temperature, age, and dilution of the infective juice, and the age of the cut surface of the stalk exposed to infection. The heaviest concentration of the causal agent is in the lower parts of the stalks, although it occurs in all parts of the plant, including the leaf and sheath. Transmission of the causal agent of the disease in Florida has been obtained by direct contact of the seedcane with diseased-stalk material. Normal flowering of C.P. 50-28 was delayed in Florida by the ratoon stunting disease. Losses from the disease vary with varieties; in Louisiana, the loss was more than 30 percent in some varieties, whereas in Puerto Rico the loss was about 25 percent. Rapid reinfection of sugarcane grown from seedcane treated with heat (hot air or hot water) to destroy the causal agent of the ratoon stunting disease, is an important source of loss to sugarcane growers in Louisiana and Puerto Rico.

Red Rot. Heavy losses are caused in Georgia by the red rot disease, Colletotrichum falcatum. These losses are due primarily to damage to the seedcane that causes a reduction in stand. Preliminary tests show that the disease is present in standing cane of susceptible varieties; however, less damage is done when the seedcane is planted in the fall than when it is planted in the spring. Tests are in progress to determine further suitable methods for controlling the disease.

Chlorotic Streak. P.O.J. 2878 and other susceptible varieties are damaged annually by the chlorotic streak in the northern, humid area of Puerto Rico. Heat treatments in water at 52° C. for 20 minutes is adequate to control the disease.

Nematodes. The ectoparasitic nematode Helicotylenchus nannus, the endoparasitic, root-knot nematode Meloidogyne incognita acrita and the root rot fungus Pythium gaminicolum were pathogenic to sugarcane and cause reduction in cane growth. But, there was no significant interaction between them when cane was grown in the presence of the fungus and either of the nematodes. There was an inverse relationship between population-levels of H. nannus and the growth (of root and of top) of sugarcane seedlings. Also, plant growth in methyl-bromide-fumigated soil was significantly greater than in non-fumigated soil.

Plans: Studies on red rot and chlorotic streak will continue on about the same level with special emphasis on selecting resistant varieties, and by developing other control measures. Mosaic studies will be strengthened under Louisiana conditions to determine the effect of new strains of the disease on all commercial varieties and the possible reason for its rapid increase in certain areas. Basic studies on the ratoon stunting disease will be conducted to identify the presence of the virus and for the development of improved control measures. The sugarcane test-plant-method for identifying the presence of the disease will be utilized in screening parental varieties and promising selections for susceptibility to the disease, and for evaluating heat treatments for controlling it. It is hoped that the work on the influence of nematodes in sugarcane production can be expanded.

Publications: Diseases in Relation to Variety Plantings in 1959. E. V. Abbott. The Sugar Bulletin 37(21):272-273. August, 1959.

Importance of Mosaic in Present Commercial Varieties of Sugarcane in Louisiana. E. V. Abbott. The Sugar Bulletin 37(15):179-182. May, 1959.

Strains of Sugarcane Mosaic in Louisiana. E. V. Abbott. The Sugar Bulletin 37(4):49-51. November, 1958.

Cerebella Andropogonis Ces. in Florida. E. H. Todd. I.S.S.C.T. Newsletter 4, August 1958: 7-8.

SWEET SORGHUM ---------- CR

Problem: Determine the distribution, prevalence, means of transmission, and methods of controlling diseases of sweet sorghum.

Program: A continuing long-term program involving basic research on causative agents and host reactions, and applied research on control measures and losses from sweet sorghum diseases is carried out in Mississippi, Louisiana, Alabama, Georgia, Tennessee, Arkansas, Kentucky, California and at Beltsville, Maryland, in cooperation with State Agricultural Experiment Stations and the Cairo Cane Growers' League, involving less than 1 professional Federal man-year annually.

Progress: Rust. Data from controlled experiments in Louisiana and Mississippi show that a heavy infection of sorghum rust caused by Puccinia purpurea reduces the sugar content of susceptible varieties approximately 20 percent. These losses vary with varieties and point up the need for developing varieties resistant to the disease.

Zonate Leaf Spot. Screening tests of 600 sweet sorghum varieties in Mississippi for resistance to Zonate leaf spot caused by Gloeocercospora sorghi show that approximately 2 percent of the varieties have a mild resistance to the disease. Further studies are in progress to isolate from the World Reference Collection more resistant varieties that can be used in the breeding program.

Smut. Smut infections in sweet sorghum late in the season present a serious problem to the sweet sorghum industry, especially in the production of seed. Normal control measures by seed treatment are not effective with this disease. Studies are in progress to determine means of infection and control.

Mosaic. A severe necrosis of sorghum leaves of certain varieties was found to be a reaction to infection by the sugarcane mosaic virus. In addition to necrosis, ordinary mosaic mottling was present in two or three of the youngest leaves of the infected plants. Resistance to mosaic seems to be less common in sweet sorghum than in sugarcane.

Publications: Rust Ratings Versus Juice Quality of Sweet Sorghums in South Louisiana, 1956. O. H. Coleman and Jack L. Dean. The Sorghum Newsletter 2 (1959):41-43.

Necrotic and Resistant Reactions to the Sugarcane Mosaic Virus in Sorghum. Jack L. Dean and O. H. Coleman. Plant Disease Reporter 43(5):522-527. May, 1959.

F. Insect Control

INSECTS AFFECTING SUGAR CROPS ---------- ENT

Problem: More effective and economical methods which will eliminate problems associated with insecticidal residues, the development of resistance to insecticides, and the preservation of beneficial insects are needed for controlling insect pests of sugar crops.

Program: This continuing long-range program of basic and applied research is conducted at Houma, Louisiana; Belle Glade, Florida; Twin Falls, Idaho; Phoenix, Arizona; Logan, Utah; and Fort Collins, Colorado; and involve 3 professional Federal man-years annually.

Progress: Sugarcane. The annual Federal-State sugarcane borer survey in Louisiana showed a crop loss of 14 percent or $6,300,000 in 1958 due to the sugarcane borer, with an average crop loss of 16 percent over the past 23 years. A fall survey in Florida showed the sugarcane borer population

was one of the lightest ever recorded in that State. In Louisiana the heaviest infestations of second generation borers were found in fields that had been treated with heptachlor the previous year for fire ant control. Infestations were generally lighter in fields treated the previous year with endrin for borer control. This was due to the fact that such good control of borers was obtained with endrin that relatively few overwintered to infest this year's fields.

In Louisiana chlordane applied at the rate of 3 pounds per acre as a spray on seed cane in the open furrow at planting time was the most effective insecticide tested against soil arthropod pests. It gave a yield increase of 13 tons of cane per acre over a two crop year period. This represents an increase of $105 per acre. The cost of treatment was $5 per acre. Endrin, heptachlor, aldrin, and malathion were each decreasingly less effective in the order given. In Florida chlordane, heptachlor, and aldrin have been found to give effective wireworm control. Excellent control of the yellow sugarcane aphid was obtained in a Florida test with Systox spray.

Tests in Louisiana with the pathogens, Bacillus thuringiensis and Beauveria bassiana, showed these organisms to be very effective against the sugarcane borer under laboratory conditions but almost completely ineffective under field conditions. In Florida thuringiensis was ineffective under field conditions in controlling a species of armyworm attacking sugarcane, but appeared promising in preliminary tests against the West Indian flugorid. This fulgorid has become extremely abundant in Florida in recent years and attempts are being made to establish one of its parasites obtained from Trinidad.

A 3 to 4 percent parasitization of first generation sugarcane borers by the Cuban fly was found on a Louisiana plantation where this parasite was released in 1954. Releases of Scymnus lady beetles and a lady beetle species from India, have been made in an attempt to establish these predators for the control of the yellow sugarcane aphid.

Sugar Beets. In preliminary field experiments in Utah in 1958 against soil arthropod pests of sugar beets, parathion plowed under before planting increased the plant stand and yield of sugar beets approximately 10 percent. Parathion applied as a side dressing after planting in 1959 resulted in a 37 percent increase in plant stand. The increase in plant stand and yield of sugar beets was believed to be due to the control of the garden symphylid.

Field insecticide tests on sugar beets grown for seed in Arizona showed that DDT was still as good as, or better than any of the newer materials for the control of the beet leafhopper. These tests also showed that a 3 percent BHC dust gave the best control of the green peach aphid. Good results were obtained in tests with a new type trailing boom sprayer-duster developed by AE.

In Idaho a possible breakthrough was made in the long continued search for a chemical control of damage by the beet leafhopper-curly top complex on

sugar beets and other susceptible crops. It was discovered that under greenhouse conditions young sugar beet, tomato, and bean plants could be given almost complete protection from curly top by applying a spray containing Thimet and sugar or the juice of sugar beets. The sugar or juice is not effective when used alone and the Thimet used alone is of little value.

The investigations of the status and economic importance of sugar beet insect problems in the Great Plains, showed a threefold need for additional research: (1) To determine source of beet leafhopper migrations that caused outbreaks of curly top disease in the area; (2) to determine where and how the insect-borne virus yellows disease overwinters, and (3) to investigate the problem of avoiding harmful insecticide residues on sugar beet tops and in other beet by-products fed to livestock.

Plans: Basic and applied investigations on ecology, physiology, pathology, and chemical, biological, and cultural control will be continued to find more effective and economical methods of controlling sugar crop pests with emphasis being placed on biological control methods of avoiding harmful insecticide residues.

Publications: Recent Attempts to Establish Sugarcane Borer Parasites in Louisiana. L. J. Charpentier. Sugar Bulletin 37(5) Dec. 1958.

Sugarcane Borer Infestation and Loss in Louisiana. L. J. Charpentier, Ralph Mathes, and W. J. McCormick, USDA, and W. H. Long and E. J. Concienne, La. Agr. Expt. Station. Sugar Bulletin 37(13) Apr. 1959.

Recommendations for Controlling the Sugarcane Borer and Other Pests in Louisiana 1959. Ralph Mathes, S. D. Hensley, and L. J. Charpentier, USDA, and W. H. Long, E. J. Concienne, and L. D. Newsome, La. Agr. Exp. Station. Sugar Bulletin 37(4) Apr. 1959.

Endrin for Borer Control. W. H. Long, E. J. Concienne, S. D. Hensley, W. J. McCormick and L. D. Newsome. Louisiana Agriculture 2(3):12-13. 1959.

Better Cane Borer Control in Louisiana. W. H. Long, E. J. Concienne, S. D. Hensley, W. J. McCormick and L. D. Newsome. Sugar Journal 24-25 April. 1959.

Un Enemigo de la Cana de Azucar. W. H. Long, E. J. Concienne, L. D. Newsome, S. D. Hensley, and R. Mathes. La Hacienda 40-42, July 1959.

Insecticide Recommendations of the Entomology Research Division for the Control of Insects Attacking Crops and Livestock - 1959 Season. USDA Handbook No. 120, Revised February 1959.

INSECT VECTORS OF SUGAR CROP DISEASES ---------- ENT

Problem: Determine the identities, distribution, life histories, and habits of the insect vectors of sugar crop diseases and develop measures for their control.

Program: This continuing long-range program of basic and applied research is carried on at Houma, Louisiana; Belle Glade, Florida; Phoenix, Arizona; and Twin Falls, Idaho; and involves 2 professional Federal man-years annually.

Progress: Sugarcane. Studies in Florida indicate that the West Indian sugarcane fulgorid does not transmit the sugarcane mosaic or ratoon stunting viruses.

Spring examinations to determine insect vector populations in N. Co. 310 cane stubble in Louisiana in an area of heavy mosaic spread and in an area of light spread, showed twice as many plants infested with the corn leaf aphid and nine times as many infested with the rusty plum aphid in the area of heavy spread as in the area of light spread. A survey of part of the Louisiana sugarcane area showed that the corn leaf aphid, the most efficient mosaic vector, is generally distributed. The greenbug, another vector of mosaic, was found in the lower Mississippi River area only.

In an experiment in Louisiana with a mosaic susceptible variety, C. P. 52-68, to control mosaic disease by control of its vectors and ants associated with the vectors, 75 percent control of the corn leaf aphid, and 100 percent control of the greenbug, was obtained with 3 biweekly applications of a chlordane-malathion combination. There was a 112 percent increase of mosaic in the treated plots compared to a 182 percent increase in the untreated plots.

In another experiment using the same treatment but a different variety, C. P. 36/105, the same control of the two vectors was obtained as in the other experiment but the percentage difference in mosaic was less between the treated and untreated plots. This was believed to be due to the fact that this variety is known to recover from the disease and to mask the symptoms.

Sugar Beets. Field tests in Arizona in 1959 showed the need of controlling the beet leafhopper (the insect vector of curly top) on curly top-resistant varieties of sugar beets grown for seed under virus yellows conditions. Curly top and virus yellows in combination caused a greater reduction in the yield of seed than virus yellows alone; whereas curly top alone did not affect the yield.

The 1958 field tests in Arizona showed the need of controlling the aphid vectors of virus yellows in the fall as well as in the spring to alleviate the damage caused by this disease in the sugar beet seed crop. It was found that the fall infestations of virus yellows-infective aphids caused a greater reduction in seed yield than spring infestations. These findings were called to the attention of growers and aphids were controlled on the 1958-59 sugar

beet seed crop during the entire season. It is estimated that the yield and quality of the 1958-59 crop will be better than any year since 1954.

Screening studies initiated in 1957 in the search for additional leafhopper vectors of the curly top virus disease were continued. Results have been negative for about 1500 specimens of various species tested.

Plans: Work on insect transmission of sugar crop diseases will be continued. Emphasis on sugarcane disease transmission will be placed on vectors of ratoon stunting disease as the transmission and spread of sugarcane mosaic by insects is fairly well worked out. On sugar beets special consideration will be given to the search for additional insect vectors of virus yellows and curly top and to the studies conducted on the sugar beet seed crop inoculated with curly top by the beet leafhopper and virus yellows by the green peach aphid.

Publications: Russian-Thistle Distribution in Southern Idaho and Eastern Oregon in Relation to Beet Leafhopper Populations. J. R. Douglass and H. C. Hallock. USDA Production Research Report No. 18, October 1958.

Laboratory Tests for Control of the Beet Leafhopper on Snap Beans Grown for Seed. W. E. Peay. Jour. Econ. Ent. 52(4), pp. 700-3, August 1959.

Cucumber Mosaic in Seed Fields of Sugar Beets in the Salt River Valley of Arizona. C. W. Bennett, H. K. Jewell, O. A. Hills. Jour. Amer. Soc. of Sugar Beet Technologists 10(3), pp. 220-31, October 1958.

VARIETY EVALUATION FOR INSECT RESISTANCE ---------- ENT

Problem: Evaluate varieties and selections of sugarcane for sugarcane borer and other sugarcane insect resistance, and determine the nature and inheritance of resistance.

Program: This continuing long-range program of basic and applied research is conducted at Houma, Louisiana, and Belle Glade, Florida, and involves 1 professional Federal man-year annually.

Progress: Sugarcane variety C. P. 52/68 which was released in 1958 for commercial production in Louisiana not only has a relatively light borer infestation but also shows considerable tolerance to sugarcane borer infestation. Agronomically C. P. 52/68, a cross of C. P. 29/320 x C. P. 38/34, is a very good variety. Of the 6 most promising unreleased varieties examined in Louisiana in 1958, 2 had a heavier borer infestation and 4 had a lighter infestation than control variety C. P. 36/105 which is average. Several of the selected varieties growing in the borer resistance nursery at Houma had a lighter infestation than variety C. P. 34/120, the most resistant commercial variety ever grown in Louisiana. Three of the 83 varieties given C. P. and L. numbers in 1958 had extremely light infestations.

Cl. 41-223, the most commonly grown commercial variety in Florida, was found to be one of the least susceptible to lesser cornstalk borer damage of the commercial varieties grown in this State.

In a stubble variety test field in Louisiana the rusty plum aphid showed a consistent preference for the mosaic-susceptible variety N. Co. 310 over C. P. 47/193 and C. P. 52/68. N. Co. 310 has a larger collar lobe than the other two varieties which affords a larger feeding area and greater protection from rains for this aphid.

Plans: The resistance program will be continued. New sources of resistance to the sugarcane borer and other sugarcane insects will be sought so that they can be used in the sugarcane improvement program being conducted by breeders.

G. Mechanization of Production and Harvesting

SUGARCANE PRODUCTION AND HARVESTING MACHINERY ---------- AE

Problem: Develop a pickup and gathering attachment for down or recumbent cane to be adapted to a cutter-loader harvester or the experimental cutter-cleaner-loader type harvester and improve experimental stripping and cleaning devices so as to reduce the loss of recoverable sugar caused by excessive trash and delayed milling.

Program: This is a continuing long-term program involving development of mechanical principles for gathering, cutting, cleaning, and loading sugarcane in one operation, conducted at Houma, Louisiana, in cooperation with the Crops Research Division, ARS, the American Sugar Cane League, and sugarcane interests in Puerto Rico, involving about 1 professional Federal man-year annually.

Progress: Redesigned stripper cylinders elevating chains, which incorporated greater flexibility in adjustment, resulted in obtaining cleaner harvested cane. The redesign of the stripping fingers reduced failure and increased the number of tons of cane harvested per set of stripping fingers to an estimated 1000 to 1500 tons. Sixty percent of the finger failures occurred in the transfer zone of the elevating chains, with machine chokes considered a contributing factor, Increasing the stripper cylinder speed approximately 40 percent above machine speed of previous years operation (of 643 rpm) resulted in cleaner cane when harvesting N. Co. 310 and C. P. 44/101 varieties. At the same time, the ground loss increased from 2.1 to 5 percent for variety N. Co. 310 while no significant increase was noted for varieties C.P. 44/101 and C. P. 36/105.

The trash content of harvested cane increased (from 2.6 to 4.1 percent) with increase in ground speed (from 1.5 to 2.7 miles per hour) but no significant differences were shown in ground loss from ground speeds.

High cane borer infestation (an increase from 10 to 30 percent of the cane joints bored) significantly increased harvester ground loss from 3.6 to 10.7 percent, but no increase in trash content of harvested cane was shown.

Capacity tests traveling at 1.9 miles per hour in standing cane showed 13.6 tons of cane harvested per hour. Of this time 53 percent was spent cutting, 28 percent was non-cutting time for placing slings in trailer for unloading purposes, and 19 percent in waiting and changing wagons.

Plans: Future work will emphasize development of gatherers for down cane and other cutter, cleaner-loader harvester components, such as conveying and stripping for more efficient operation. An improved stripping mechanism with increased efficiency, capacity, and increased life needs to be developed before a once-over cane harvester will be commercially accepted.

II. UTILIZATION RESEARCH AND DEVELOPMENT

A. Chemical Composition and Physical Properties

SUGAR BEET COMPOSITION IN RELATION TO PROCESSING ---------- WU

Problem: The lack of a clear understanding of the detrimental effects of nonsugar substances in sugar manufacturing is limiting the development of improved processing procedures.

Program: A continuing investigation on isolation, identification and analysis of the components of sugar beet juices, molasses, and pulp for use in developing improved and new purification procedures involves a total of 3 professional Federal man-years annually.

Progress: Analytical data on Steffen molasses samples has shown a correlation between chloride, acidity, and effectiveness of sugar removal. A method has been developed for determining the amount (weight) of acidic substances in molasses using ion exchange fractionation.

In addition to the analyses of molasses, the nitrogen compounds, known to be deleterious to processing of beets for sugar, have been fractionated into groups by ion exchange and the fractions analyzed. No new compounds have been positively identified.

Analytical data from molasses analyses were submitted to the Biometrical Services, ARS, for machine computation to determine the relationships, if any, between nonsugar constituents and sucrose.

Thirty samples of molasses (seasonal composites from all beet production areas of the U. S.) are being analyzed to confirm the 1958 finding that for every pound of chlorine salts in the molasses, there are five pounds of sugar. The inference is that the chlorides may influence the amount of sugar carried over into the molasses.

The rate and extent of crystallization of sugar has been studied using a dilatometer. Comparative rates of crystallization of pure sucrose, as compared to sucrose in the presence of nonsugars, were measured with this instrument. It has not yet been possible to interpret the experimental results so that rate constants can be calculated.

Research to develop basic information on the surface changes that accompany the decreases in supersaturation during crystallization requires the accurate measurement of surface areas of fine crystals before the mechanism of sucrose crystallization can be understood.

Previous studies showed that sugar beet araban fractions had molecular weights three times that previously reported. Results now show the presence of still larger molecules in the range of molecular weights near 100,000. This material may be potentially valuable and useful as carbohydrate gum.

Plans: When the analytical data are received from Biometrical Services, they will be scrutinized for leads as to which nonsugar molasses constituents are responsible for carrying sugar over into the molasses. Means will then be sought to prevent this carryover.

Attempts to resolve the unknown nitrogen compounds of molasses will be continued.

Rate studies of sucrose crystallization and investigations of the solubility of sucrose in the presence of molasses nonsugars will be conducted.

Researches on the physical nature of araban will be undertaken to establish its potential usefulness for industrial purposes.

Publications: Multiple Sample Continuous Dialyzer. J. B. Stark. Chemist Analyst. 48: No. 1, 17, 1959.

Separations of Nitrogenous Compounds. J. B. Stark. U. S. Patent No. 2,891,945. June 23, 1959.

Molecular Weights of Sugar Beet Araban Fractions. Y. Tomimatsu, K. J. Palmer, A. E. Goodban, and W. H. Ward. J. Polymer. Sci. 36: 129-139, 1959.

Reaction of Hydroxylamine with Pectinic Acids. Mildred Gee, R. M. Reeve, R. M. McCready. J. Agri. & Food Chem. 7:34-38, 1959.

COMPOSITION AND QUALITY EVALUATION OF SUGARCANE FOR PROCESSING -------- SU

Problem: Knowledge of composition of sugarcanes and their products are needed to evaluate the potentials of new varieties, to improve sugar recovery in processing, and to relate processing characteristics and quality to composition.

Program: A continuing, long-term program involving basic analytical investigations of the composition of sugarcane juice, sirups, and sugars, obtained from pilot plant experimentation on milling and processing, carried on at New Orleans, Houma, and Baton Rouge, La., and in cooperation with Louisiana State University, the American Sugar Cane League, and with growers and processors of sugarcane, involving about 6 professional Federal man-years annually.

Progress: Experiments were continued at the Audubon Factory of Louisiana State University during the 1958 grinding season to obtain the pilot plant processing data required by the Contact Committee of the American Sugar Cane League as part of the overall evaluation of new canes considered suitable for commercial planting. The League cooperated by providing large sample lots of the canes, and data on milling were obtained by the staff of Louisiana State University engaged in a study of improved cane sampling procedures. Standard lime charification of the juices of the two new

commercial canes processed resulted in better clarities this season than those produced on the average in previous tests. Together with higher rates of clarification relative to the standard cane which were maintained in this season's experiments, these results provide assurance that the new canes will be equal or somewhat superior in processing to the principal commercial variety which they will replace eventually. The one unreleased cane tested could be clarified at a satisfactory rate, but lime clarification produced juices of extremely poor clarity.

Work has been continued on the determination of the organic non-sugar constituents of cane juice which interfere with clarification and the subsequent crystallization of sugar. A sample of the juice of each variety of cane tested in the pilot plant was preserved by freeze-drying and analyzed for the nine-non-nitrogenous organic acids and the 16 free amino acids, as well as those produced by hydrolysis of the non-dialyzable protein material in cane juice. The results are compared with processing data for corresponding varieties from previous years. Work was also continued on attempts to isolate and identify the non-sugar carbyhydrate-like substances and organic phosphorous-containing compounds which may play an important part in clarification.

Information on the variability of some of the constituents under study as they occur in other areas was obtained to supplement data on composition of juices from the cane used in the pilot plant experiments, nearly all of which is grown at one plantation. Values determined by analyzing relatively stable blackstrap molasses may be calculated to percentages in cane through the weight of cane ground and molasses produced. Molasses composites for a 4-week period in November, and the necessary factory data for cane ground and molasses produced, were obtained from 10 factories selected to represent different areas of the sugarcane belt.

The pilot plant facilities were used in a cooperative experiment designed to obtain fundamental information on the nature and extent of reactions of glucose that affect processing of sugarcane juice and recovery of sugar, by subjecting glucose labeled with radioactive C-14 tracer to the conditions of continuous processing and sugar production. The work was done in cooperation with the New York Sugar Trade Laboratory, which furnished the C-14 labeled glucose. Arrangements had been made with Louisiana State University to authorize the use of this material in the Audubon Factory under the supervision of the Radiation Safety Officer of the University. Samples of materials available from the experiment will be useful in current projects on the study of juice composition and changes in composition during processing.

Plans: This long-range investigation will be continued, and expanded wherever possible to accelerate the systematic accumulation of data and to provide the more complete knowledge of the composition of sugarcane juices required for effective research on all phases of sugarcane processing and cane sugar refining and utilization. Pilot plant research will be re-oriented toward investigation of improved processing methods for reducing costs and increasing recovery of sugar from new cane varieties. Information

that has been acquired on composition will be applied in devising improved analytical procedures and better criteria for evaluating the quality of cane for production of raw sugar.

Publications: Fresher Cane Increases Sugar Recoveries and Profits for Both Growers and Processors. W. F. Guilbeau, E. E. Coll, and L. F. Martin. Sugar Bulletin Vol. 36 No. 24 page 343-346, September 15, 1958.

Processing of New Commercial and Unreleased Sugarcanes in Comparison with the Standard Commercial Cane in Pilot Plant Clarification. W. F. Guilbeau, E. E. Coll, and L. F. Martin. The Sugar Bulletin Vol. 37 No. 3 Page 29-42, November 1, 1958.

Evaluation of Sugar Cane Varieties -- 1956 and 1957 Grinding Seasons. Carl W. Stewart. Engineering Experiment Station Bulletin No. 63, Louisiana State University 1958.

Sugar Impurities. Composition of 'Floc' Formed in Acidified Sirups from Refined Granulated Cane Sugars. Mack F. Stansbury and Carroll L. Hoffpauir. J. Agricultural & Food Chemistry Vol. 7 No. 5 page 353-358, May 1959.

USDA Clarification Tests - Experiments During 1958 Louisiana Crop. W. F. Guilbeau, E. E. Coll, and L. F. Martin. Sugar Journal Vol. 22 No. 12 page 23-24 May 1959.

Processing of New Commercial and Unreleased Sugarcane in Comparison with the Standard Commercial Cane in Pilot Plant Clarification. W. F. Guilbeau, E. E. Coll, and L. F. Martin. Sugar Bulletin No. 37, Vol. 3 page 29-42, November 1, 1958.

Acetylation and Oximation: Assay for Certain Oxygen-Bearing Groups in the Dialyzed Browning Products from Cane Final Molasses. W. W. Binkley. Internation Sugar Journal Vol. 60 page 322-323 (1958).

Processing of New Commercial and Unreleased Sugarcane. Results of Clarification Experiments During the 1958 Season. W. F. Guilbeau, E. E. Coll, and L. F. Martin. Sugar Journal Vol. 22 No. 12 page 23-24 May 1959.

B. New and Improved Food Products and Processing Technology

SUGAR BEET PROCESSING PROCEDURES AND EQUIPMENT ---------- WU

Problem: The lack of information on variables in the production of juice, sugar, and pulp from sugar beets has limited the efficiency in processing.

Program: A program on the design, installation and testing of equipment for laboratory-scale sugar beet processing, conducted at Albany, California, involves 3 professional Federal man-years annually.

Progress: Most of the machine design and equipment installation and development of methodology has now been completed in the small-scale sugar-beet processing plant. Investigation of different process variables is being conducted.

Settling Aids on Precipitation of Carbonation Mud: The most important step in the purification of beet juice during sugar manufacture is the continuous liming and carbonation purification treatment. With present equipment the sludge must settle quickly and efficiently so that the clarified juice can be continuously decanted. Studies of the variables important in carbonation included the use of settling aids to increase rates of sludge sedimentation.

In recent years more than a dozen settling aids have appeared on the market, each with claims for effective acceleration of beet-sludge sedimentation. Six of the most promising materials were tested in the processing plant. Three of these aids were ineffective and three showed varying degrees of effectiveness for increasing the sedimentation rates from 10 to 20%.

Alkaline Battery Supply Water: A majority of U. S. Beet sugar factories produce dried pulp which is usually used as a stock feed. Wet exhausted pulp from the diffusion battery is pressed as dry as possible before final drying. A number of factors are involved in the level to which wet pulp may be pressed, but two most important conditions of diffusion, the temperature and pH of diffusion water, markedly effect the firmness and pressability of pulp.

Standard factory procedures call for reuse of condensate from the evaporators as part of the diffusion battery supply water. When this is done, however, this water contains ammonia in amounts of up to 100 ppm which is added directly to the pulp end of the diffuser. The effect of this level of ammonia, when added to unbuffered distilled water in the laboratory diffuser, has been found to be very deleterious to the pulp characteristics and to processing efficiency. Use of ammonia water produces an increase of 80 lbs. of water per 100 lbs. of press cake solids. This additional water in pressed pulp puts an unnecessary load on the pulp drier. In addition to this deleterious effect, the press juice soilds are doubled causing an increase in the B.O.D. (Biological Oxygen Demand) of the waste. The ammonia treated pulp is also considerably softer, so that undesirable pulp particles becoming entrained in the diffusion juice impair efficiency of purification procedures.

Dried Cossettes. A major problem for the farmer and the processor is the expense incurred as a result of regulated harvesting in areas with high night-time temperature or the loss of sugar during factory handling of beets where storage piles are maintained for periods of up to three months. A system which would allow the farmers to harvest beets of the highest sugar content at will, and permit the factory to operate over a longer period without the losses incurred as a result of maintaining a supply of factory beets, would result in large savings to both groups. One solution to the problem

would be to process beets to dried cossettes at the time of harvest, store the dried material, and operate the factory during the remainder of the year on the dried beet material. Some work has been done on this problem by groups in industry in the United States and several parts of the world over the past thirty years. A completely satisfactory scheme universally usable apparently has not been found because only one factory in the world (Italy) presently operates on dried beets.

Exploratory experiments have been conducted in the processing plant on cossettes dried in commercial equipment and in a developmental belt-trough dryer. The sugar was easily extracted, but the solutions were highly colored, due in part to caramel formed by high temperatures during drying. Laboratory studies indicate that standard purification procedures may be satisfactory.

Plans: Construction of a continuous settling device for carbonation mud will be completed and the device will be tested in the beet processing plant.

Further research required on the determination of optimum conditions of pulp treatment during and after diffusion to maintain and improve pulp dewatering efficiency will be conducted.

Additional studies will be made to determine optimum drying conditions for preparation of dried sugar beet cossettes as a stable source material for sugar manufacture. Optimum processing conditions using dried cossettes will be determined.

Publications: Processing of Sugar Beets, US Patent No. 2,873,220. L. E. Brownell and S. A. Zieminski. February 10, 1959.

Machine for Pulping Sugar Beets. L. E. Brownell and S. A. Zieminski. U. S. Patent No. 2,858,079, October 28, 1958.

Theoretical Steady State Distribution of an Additive in Sugar Beet Diffusers. Fred Stitt. J. Am. Soc. Sugar Beet Technologists 9: No. 7, 611-631, 1957.

LOSS OF SUGAR FROM FACTORY SUGAR BEETS ---------- WU

Problem: Factory beet supplies, required for continuous factory operations, lose sugar by respiration of beets and by microbial infection during storage and early stages of processing.

Program: A continuing program of applied and fundamental investigations to determine the causes and means of preventing such losses is being conducted at Albany, California, and at Oregon State College, Corvallis, Oregon, involving 3 professional Federal man-years annually.

Progress: Changes in Composition of Factory Beets. No gross chemical changes were observed in composition of harvested beets that could account for the large direct sugar and processing losses. An important finding has resulted from chemical analyses of the processed juices. Raffinose, a carbohydrate produced at the expense of sucrose and known to be deleterious to crystallization of sugar, was found to accumulate in the beets maintained at 34° F. A four-fold increase in raffinose occurred in beets held at this temperature. This may explain the observation that in areas having low night-time temperatures the efficiency of processing decreases as the season progresses. No changes in raffinose concentration occurred in the beets held at ambient temperatures. This may explain in part why beets grown in California under conditions of high night-time temperatures have been found to be low in raffinose.

Sucrose Metabolism in Factory Beets. In order to devise means of decreasing sugar losses due to respiration of beets at the factory, it is first necessary to understand the enzymatic mechanisms and pathways by which sucrose is utilized and synthesized.

Radio-isotope studies conducted cooperatively by Oregon State College showed that sugar beets are not unique in their carbohydrate metabolism and findings from researches on plant enzymes from most high plants can be confidently applied to factory sugar beets.

Enzymatic studies on phosphate-containing metabolites from sugar are hampered by lack of simple methods for their evaluation. A method for the improvement in analyses of sugar beet enzymes and metabolites using the ultraviolet fluorescence of quinine and sulfosalicylic acid on paper chromatograms was developed. This promising procedure will aid in tracing the initial pathway of sucrose breakdown prior to its final breakdown to carbon dioxide and water in harvested sugar beets.

Plans: Future plans include identifying the magnitude of sugar losses in factory beets, due to (1) respiration, (2) microbial infection, (3) accumulation of raffinose. Should fungicidal treatments or respiration inhibitors appear feasible, it will be necessary to trace the fate of these chemicals through processing operations and ultimate concentration in sugar, molasses, and pulp. Research will also continue on estimating the catabolic pathways of sucrose in factory sugar beets and investigating remedial means to reduce root respiration and save substantial amounts of sugar.

Publication: Ultraviolet Fluorescence of Quinine Sulfate for Detection of Phosphate Ester Spots on Paper. E. S. Rorem. Nature 183: 1739-1740, 1959.

ION-EXCHANGE SUGAR ---------- SU

Problem: Determine the feasibility of applying novel processing methods to obtain increased recovery of sugar of a grade suitable for direct utilization by industrial food users.

Program: A limited-time program involving chemical engineering and development research on a pilot plant scale to establish process economics and to produce adequate quantities of sugar for evaluation by industrial users, carried on at New Orleans and Baton Rouge, La., and at the Puerto Rico Agricultural Experiment Station, as well as sugar companies, and in cooperation with MD, and involving about 3 professional Federal man-years annually.

Progress: The grade of sugar suitable for direct consumption was produced on a pilot plant scale by ion-exchange purification of the clarified juices obtained in the processing tests of new canes at the Audubon Factory of Louisiana State University. Alternate experiments were carried out with the reverse cycle arrangement of resins used in previous work and with the addition of a mixed-resin exchanger, regenerated with salt, ahead of the usual three exchangers. The latter system offour exchangers effected some economy in total regenerating chemical requirements, while producing sugar equal in quality to that obtained in the conventional reverse cycle. The sirups from each of the methods of operation were boiled separately to crystallize sugar, identical sugar boiling procedures being employed in each case. A total of 2,100 lbs. of sugar of uniform quality was produced by blending the two lots of dried sugar.

A large candy manufacturing firm is evaluating all of the sugar in factory scale production of types of candy for which they currently use refined sugar. If the ion-exchange sugar proves suitable for a sufficient volume of their production, they will estimate the price at which this grade can be used advantageously to replace this volume of the more expensive refined sugar as well as all of the turbinado sugar they now require. The same company has found in previous plant tests that the ion-exchange grade is equal or superior to turbinado in those candies now being made from the more highly colored sugar. They consume 13-14,000 tons of turbinado sugar and a larger volume of refined cane or beet sugar annually, in a varied line of candies, including some of the most popular candy bars.

Economics of the reverse cycle process, without the additional salt cycle exchanger, were reevaluated on the basis of average and attainable operating requirements and results of the large pilot plant experiments completed during the 1956-57 grinding seasons. The estimated installation and operating costs, including depreciation and interest on an investment of $1-1/4 million, with recovery of an extra 7 lbs. of the higher grade sugar per ton of cane, indicate that addition of ion-exchange purification to the conventional raw sugar process will be profitable if a market can be developed for a substantial volume of the direct consumption sugar at 7-1/2¢ per pound. The estimates were made for a mill grinding 3,000 tons of cane per day, and factory production of about 20,000 tons of ion-exchange sugar during a Louisiana grinding season. No credits were taken for byproducts potentially recoverable from the material removed from the ion-exchange resins in regeneration.

Reappraisal of the economic status of this project was sufficiently promising to warrant intensified development work and market surveys to ascertain the potential demand and price ranges for the direct consumption grade of sugar. Future experimentation will be directed toward further reduction of dilution and sucrose losses to establish more nearly optimum operating conditions. A major factor requiring attention is the determination of the service life of the exchange resins used, and modifications of the process or the resins used to provide adequate retention of exchange activity in repeated use cycles, and minimize resin replacement costs.

Cooperative research was continued with the Experiment Station of the University of Puerto Rico at Rio Piedras during the intervals between Louisiana grinding seasons. Juice is available there from January through August or September, and is used in experiments in a small pilot plant installation of about one-sixth the capacity of the ion-exchange plant at the Audubon Factory in Baton Rouge, La. Experiments on the smaller scale provided useful data on various combinations of resins, on effective procedures for recycling regenerating acid and alkali to reduce chemical costs, and preliminary results of the effectiveness of the additional salt-regenerated column. A separate phase of the work, initiated in 1958 and continuing during the current season in Puerto Rico, is on the upgrading of raw sugar to produce a partially inverted, low ash content liquid sugar suitable for candy manufacture and other industrial uses. A large sugar refiner, also operating the largest candy plant in the Island, is particularly interested in the application of the process which would be economically advantageous there.

Plans: The pilot plant work will be continued until conclusive data are obtained on economics of the ion-exchange process for application in Louisiana; cooperation of a large factory in Puerto Rico is being considered to expand the work there by providing sufficient juice for operation of the large scale pilot plant equipment in adapting the process for use in the Island. Cooperation will be continued with a large confectionery manufacturer in evaluating this grade of sugar by large scale candy production tests, and determining the market potential in cooperation with MD.

Publication: Progress in Cnady Research, Report No. 32. L. F. Martin, Alva G. Smith, and B. J. Otilio, Jr. Processed publication published and distributed by National Confectioners' Association, 18 pages, July 1958.

C. New and Improved Feed Products and Processing Technology

DRIED SUGAR BEET ROOTS FOR POULTRY FEED ---------- WU

Problem: A potential market for the sugar beet root is its conversion into a dehydrated product suitable for animal feed.

Program: Production and feeding trial evaluation of dried sugar beets at Albany, California, involving 1 professional Federal man-year annually.

Progress: Freshly harvested sugar beet roots were washed, sliced, and dried in a laboratory tray dryer. Other samples of dried beet cossettes dried in a commercial dryer were obtained from a sugar company for comparative purposes.

Cooperative feeding trials with these materials showed that 36% of the total diet of chicks could be substituted by commercially dried sugar beets replacing the common feedstuffs without significant reduction in chick growth. It was found that the commercially dried beets could supply a greater proportion of the ration without inhibition of growth than the laboratory-dried samples. Whether dried sugar beets are used as a feedstuff depends upon the relation of their cost to that of competitive feedstuffs.

Plans: A manuscript setting forth the information obtained will be prepared for publication. No further work is contemplated in the immediate future.

D. New and Improved Industrial Products and Processing Technology

INDUSTRIAL CHEMICALS FROM SUGAR ---------- WU

Problem: Successful conversion of sucrose into industrially useful chemicals might lead to a greatly expanded market for sugar crops.

Program: A continuing program involving 1 professional Federal man-year annually, is devoted to a study of the preparation of chemical end products or intermediates of potential industrial importance from sugar.

Progress: Sucrose esters and ethers have been prepared and studies are in progress to characterize them. Experiments have shown that of the three primary and five secondary hydroxyl groups, some are more reactive than others. In all cases of sucrose ester synthesis so far attempted, a mixture of related products was obtained rather than a single pure compound. Carboxymethyl ethers of sucrose so far prepared have not appeared to have commercially useful properties.

Plans: Studies will be undertaken to determine the reactivity of the various hydroxyl groups of sucrose and to determine ways of separating pure compounds from mixtures. Research will be conducted to develop means of producing sucrose esters of known composition because some of these compounds are known to have excellent detergent properties and may well find their way into commercial use.

MICROBIAL PRODUCTION OF ORGANIC ACIDS FROM SUGAR CROPS ---------- NU

Problem: Fermentative conversion of sugar and sugar products to industrially useful and valuable products such as organic acids, might provide expanded outlets in fields not competitive with foods and feeds.

Program: Investigations on fumaric acid production are one phase of a continuing program directed toward the production of industrial products from sugars by microbial methods; this work, carried out at Peoria involves about 2 professional Federal man-years annually.

Progress: A strain of the mold Rhizopus arrhizus yields 60 to 70 g. of fumaric acid per 100 g. of sugar; fermentation time is 3 days with 10 percent sugar solutions at which time sugar is exhausted. Small amounts of malic and succinic acids are also produced. Nitrogen and salt requirements have been determined for optimum yields. Corn-steep liquor is beneficial, and the presence of 1.5 percent methanol in the culture medium increases yields up to 25 percent.

Factors pertinent to the fermentative production of fumaric acid from sugar or molasses have been sufficiently investigated for commercialization.

Work on fumaric acid has been completed and about 10 companies are interested in the fermentative production of fumaric acid, and 3 are actively engaged in developmental work based on this investigation.

Plans: Additional research is now being planned for the development of fermentative processes for the production of alpha-ketoglutaric acid, a new chemical intermediate with industrial promise, that is not readily made by synthetic processes.

Publication: Production of Fumaric Acid by Rhizopus arrhizus. R. A. Rhodes, A. J. Moyer, Mabel L. Smith, and Sinah E. Kelley. Appl. Microbiol. 7(2): 74-80 (1959).

III. MARKETING RESEARCH

A. Market Potentials, Preferences and Development

MARKET POTENTIALS FOR NEW OR IMPROVED SUGAR PRODUCTS ---------- MD

Problem: Economic information is needed on market potentials for new uses and new or improved sugar products to assist in maintaining or expanding markets for sugar and sugar using products.

Program: A continuing program to provide economic and market appraisal of new products and developments in cooperation with SU New Orleans and industrial sugar users. It involves less than one professional Federal man-year annually.

Progress: Several evaluations have been obtained of the possibilities of using ion-exchange sugar in candy making and in bakery products. These tests have not demonstrated conclusively specific applications for which ion-exchange sugar is more suitable. Research on the potential for ion-exchange sugar in industrial use has been discontinued.

Plans: New products and new uses will be tested and evaluated as they become available.

B. Costs, Margins, and Organization of the Marketing System

INDUSTRIAL MOLASSES MARKETING ---------- OC

Problem: Feed mixers, direct feeders of molasses and distributors need to know the quality of blackstrap molasses and the relationship between prices paid and feeding quality.

Program: A two-year program of applied research through contract at the Texas Agricultural Experiment Station and in cooperation with feed control officials of Texas, Louisiana, Florida, and California, and the Bureau of Customs, involving less than 1 professional Federal man-year annually.

Progress: A total of 466 samples of molasses from domestic and foreign supply areas were collected and analyzed. Practically no relationship was found between price users paid and the quality as measured by total sugar, moisture, and degrees Brix of molasses. Approximately one-third of the molasses distributed in Texas for use in livestock feeds contained 27 percent or more moisture, which, if used at the 10 percent level in feeds, would make them susceptible to spontaneous heating and spoilage.

From biological assays it appears that carbohydrate or sugar is the most important feed constituent in molasses and should be included in any measure of quality. Moisture content is critical in the control of spoilage in mixed feeds and should also be included in measuring quality. In addition to limiting the term blackstrap to cane molasses, a combination of total sugar and moisture to form grades or guides was recommended for consideration by

sellers and buyers and appropriate regulatory agencies. The following was suggested as guides to possible grades:

a. Superior Blackstrap Molasses -- cane molasses containing 23.4 percent or less water and 53.5 percent or more total sugar.

b. Blackstrap Molasses -- cane molasses containing 23.5 to 26.4 percent water and 48.5 to 53.4 percent total sugar.

c. Utility Blackstrap -- cane molasses containing 26.5 percent or more water and 42.4 to 48.4 percent total sugar.

Plans: Work is completed on this problem.

Publication: Factors in Developing Grades and Standards for Blackstrap Molasses for Feed. L. R. Richardson. USDA, MRR No. 302. January 1959.

SUGARCANE SAMPLING, TESTING, AND PRICING ---------- OC, BS

Problem: More precise and efficient methods for sampling and testing sugarcane are needed which will accurately reflect variations in quality of individual farmers's deliveries. Price incentives for high quality will encourage producers to use improved varieties and practices.

Program: A two-year program to improve sampling, chemical analysis of farmers' sugarcane deliveries for sucrose content, purity, and fiber, and an economic evaluation of methods carried on through contract at Louisiana State University in cooperation with the American Sugar Cane League and raw sugar mills in Louisiana.

Progress: Average sucrose contents obtained during the 1958 harvest season by the "Farrel-Mill" procedure and the Louisiana State University Audubon pilot mill procedure were in reasonably close agreement, but the average "Farrel-Mill" purity results were about 2-3 percent lower. The newly developed "Chipper-Waring Blendor" analytical procedure gave a sucrose content which averaged slightly below the mill determinations, while the average purity was 1-2 percent lower. The averages of the fiber determinations from the two procedures were similar.

The "Mechanical Grab" sampling method gave sucrose, purity, and fiber contents which were reasonably close to those of the mill, after adjustments for bias in analytical procedure. The hand sampling method gave a sucrose content higher than the mill average.

Studies on variability of samples taken from the same bundles of cane by the "Mechanical Grab" technique indicated that variability of sucrose content and purity lessens as the cane matures. The coefficient of variability of samples of mature cane taken by this device was less than 3 percent.

Research was continued with the "Core" sampler, a new device designed to cut sample cores from intact bundles of cane.

The number of sucrose and purity samples drawn and analyzed and number of trash tests depend on the number of farmers delivering sugarcane to the raw sugar factory and size of deliveries. The number of tons of sugarcane per test for sucrose and purity varied from 5.6 to 142.8 and tons per trash test varied from 23 to 61.

Labor requirements for sampling and testing farmers' deliveries of sugarcane for sucrose and purity and trash vary widely. Among 15 raw sugar mills, average man-hours per test for sucrose and purity ranged from 0.2 to 3.2 and average cost varied from $0.46 to $2.17. Trash tests required from 0.2 to 1.2 man-hours and average cost varied from $0.61 to $1.48. Neither the man-hour requirements nor the labor cost per test was closely associated with frequency of tests or number of tons of sugarcane per test. Comparisons of equipment cost for sampling and testing are being prepared.

Plans: Data collected during the two-year period will be analyzed and evaluated. Work will be continued on the improvement of the Chipper-Waring Blendor analytical techique and on the testing of the "Core" sampler.

MARKETING PUERTO RICAN AND MAINLAND RAW SUGAR ---------- OC

Problem: Puerto Rican and mainland raw sugar producers need information to aid them in selecting the method of selling which will yield the greatest returns and information on handling practices which minimize storage and shipping losses.

Program: A limited program of applied research on the problems on storage, shipping, and pricing raw sugar from Puerto Rican and mainland areas, in cooperation with the Puerto Rican Agricultural Experiment Station at Rio Piedras, P. R., raw sugar producers, and sugar refiners, involving about 2 professional Federal man-years annually.

Progress: A report of the study of marketing and pricing Puerto Rican raw sugar has been prepared for publication. This study showed a large shift in recent years, by Puerto Rican raw sugar producers, to selling on the basis of the average of New York spot price quotations and also a shift to selling to operators rather than directly to refiners. Operators bought almost exclusively at average prices and refiners increased the quantity of their purchases at average prices. There was also a trend toward the use of longer average pricing periods in the sale of raw sugar. The result of these shifts is to decrease the volume sold in the price-making market and to pass a larger share of the pricing responsibilities to the operators who buy the sugar.

A detailed study of more than a dozen shipments of bulk raw sugar from Puerto Rico to North Hatteras ports was made between May and September 1959. Data have been collected on weighing, loading, condition of ship's holds before loading, and weather conditions while loading at Puerto Rican terminals. Similar information has been collected at the mainland ports during discharge of the cargo. Differences between loading and discharge weights vary widely but not as much as in recent years.

Plans: Work during the coming year will include an analysis of data collected on individual shipments of raw sugar from Puerto Rican terminals to mainland ports, analysis of losses in transit from raw sugar mill to shipping terminal, and losses during storage at terminal and in raw sugar mill warehouses.

MARKETING SUGAR BEETS ---------- OC

Problem: More information is needed of the methods and practices in marketing sugar beets in relation to their influence on costs, returns and marketing margins in order to determine areas where greater efficiency would increase returns to producers and processors.

Program: A continuing economic analysis by producing areas of methods of marketing and pricing sugar beets, in cooperation with growers and processors, and involving about 1 professional Federal man-year annually.

Progress: A study is being made of the structure and conditions of the market in which sugar beets are sold, in relation to the returns to growers. Production of sugar beets is a contract-farming enterprise, in which the marketing function is in part integrated with the production process. In many areas sugar beets are a major farm enterprise and within the structure referred to, marketing is a process of organized bargaining that encompasses many factors in addition to price. This process and the accompanying cooperative activities comprise an important factor in the continuing development of more efficient beet sugar production.

Plans: The current study of marketing structure and its functioning in the industry will be completed and a report prepared. Further analysis of pricing methods will be made.

PROCUREMENT, PROCESSING, AND DISTRIBUTING SUGAR ---------- OC

Problem: Improved efficiency in marketing is dependent upon a better understanding of practices, organization, and changing methods of procurement, processing, and distribution of refined sugar.

Program: A continuing analysis of current practices and trends in refined sugar marketing in the United States, involving about 1 professional Federal man-year annually.

Progress: Data have been collected and are being analyzed on cane sugar and beet sugar plant capacity, location of processing plants in relation to population, merchandising practices, methods of distribution, and trends in use of bulk and liquid sugar over a period of years. Tentative conclusions indicate increasing importance and use of barge lines and motor trucks in the distribution of refined sugar. The latest information available indicates 52 percent of all refined sugar shipped by primary distributors is transported by motor truck. Approximately 26 percent of total refined sugar delivered by primary distributors to industrial users in 1958 was liquid sugar. This represents an increase of approximately 5 percent over 1953 deliveries. Bulk sugar usage also increased. In 1958 approximately 15 percent of all sugar deliveries by primary distributors for industrial and institutional use was bulk sugar. This was approximately 3 percent more than 1957. Based on 1955, deliveries by primary distributors

to industrial users increased 7 percent from 1955 to 1958. The largest increases occurred in the ice cream and dairy products industry--15 percent--and the canned, bottled, frozen foods, jams, and jellies industry--15 percent. Deliveries of retail-size packages of sugar were 35 percent of all sugar deliveries in 1958, the same as in 1955.

Plans: Work will be continued to analyse the market structure including pricing practices of refined sugar.

Publication: Trends in the United States Sugar Industry--Production, Processing, Marketing. USDA, MRR No. 294. December 1958.

SUGAR PRICE SPREADS ---------- OC

Problem: The industry and public are concerned about the increasing cost of marketing sugar. Information is needed on the size of marketing margins, the costs and services involved, the changes that are occurring, and factors causing the changes.

Program: A continuing analysis to measure and explain the marketing and processing costs at various stages in the movement of sugar from producer in sugar beet and sugarcane areas to the consumer, involving about 1 professional Federal man-year annually.

Progress: Most marketing costs have increased since 1950. Rail transportation rates increased approximately 32 percent from 1950 to 1957, average hourly earnings of employees in the sugar industry increased 40 percent, and costs of packaging materials, plant and equipment, fuel, and power also increased by various percentages. It appears that the major trends of this period have continued into 1959. Net profits of sugarcane refiners, after income tax payments, expressed as a percentage of net worth, decreased 2 percentage points from 1950 to 1957, and the net profit of sugar beet processors decreased 0.7 of the percentage point. There was considerable variation in the marketing margins on sugar from different areas and between cities studied. Marketing charges in 1957 ranged from 6.9 cents per pound for mainland cane sugar marketed in Chicago to 7.3 cents per pound for Puerto Rican sugar marketed in the same city. Some of this difference is due to variations in the amount of transportation, handling, and selling costs. As a result, farmers' returns ranged from 4.1 cents per pound for mainland cane sugar to 3.7 cents per pound for Puerto Rican cane sugar. Returns ranged from 4.6 to 3.6 cents per pound in 1950. Consumers paid approximately 13 percent more for a pound of sugar in 1957 than they did in 1950, largely because of increases in marketing costs.

The retail price of sugar during 1958 averaged 11.3 cents per pound, up 0.3 cent over 1957. The sugar beet farmer received 4 cents for the sugar made from his beets. The farmer's share of the consumer dollar spent for sugar in 1958 was 36 cents. For the second quarter of 1959, the retail price of sugar averaged 11.3 cents per pound. The farmer received 4 cents or 36 percent of the consumer's dollar, the same as during 1958.

Plans: Work on marketing margins will be carried on to provide as nearly current data as possible on a continuing basis.

Publication: Marketing Margins for Sugar. L. C. Larkin and Alma W. Updike. USDA, MRR No. 311. March 1959.

LONG-RUN DEMAND FOR SUGAR ---------- OC

Problem: Farmers, processors, and marketing agencies need long-range projections of demand for sugar and the effect of population growth as a basis for planning future operations.

Program: A program to evaluate the long-run demand for sugar including the effect of projected population growth and shifts in geographic location on productive capacity, processing, and marketing facilities for sugar. It involves approximately 1 professional Federal man-year annually.

Progress: Program is being initiated this year.

Plans: A study will be made of population projections, prospective demands, shifts in sugar using industries associated with shifts in populations and their effect on total sugar requirements, form of sugar demanded, and the effect on processing and marketing facilities. Projections will be made to 1980.

COMPETITIVE POSITION OF SUCROSE AND NONSUCROSE SWEETENERS ---------- OC

Problem: The market formerly held by sugar is now shared with non-sucrose sweeteners. Sound planning by producers, processors and distributors would be facilitated by more knowledge of extent and trends in substitution and factors affecting it.

Program: An analysis of the competitive position of sucrose and nonsucrose sweeteners in the United States involving about 1 professional Federal man-year annually.

Progress: Work was directed toward the collection and analysis of data on volumes, price, channels of marketing, and importance of various uses of nonsucrose sweeteners.

During the period 1949-58, total corn sirup consumption increased approximately 29 percent. The largest increases in use were by the ice cream and canned food industries. Total dextrose consumption increased approximately 21 percent and the greatest increases in use were by the confectionery and bakery industries.

Use of synthetic sweeteners, sodium and calcium cyclamates and saccharine, increased substantially over the past 10 years. The greatest increase in use of synthetic sweeteners occurred in the beverage and canning industries.

Consumption of sweeteners such as honey and maple products increased slightly, while sorgo sirup and other sweeteners decreased.

Plans: Collection of data from industrial users on the substitutibility between sweeteners, with emphasis on corn sweeteners and synthetics; competitive prices; and channels of marketing will be continued.